YAMAHA

ROBOT VISION SYSTEM

RCX240 Connection Manual

External Vision

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E130

Ver. 1.01

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About this manual

This manual describes how to combine YAMAHA's multi-axis robot with a general-purpose image sensor so as to construct a vision system.
Before constructing a system, thoroughly read this manual and the manuals for robot controller and image sensor to fully understand their contents.
For details about how to operate the robot controller and image sensor, etc., refer to the manuals listed below.

Robot controller	YAMAHA's 4-Axis Robot Controller RCX240 User's Manual, RCX240 Operation Manual
Robot language	YAMAHA's RCX Series Programming Manual
Communication software "VIP+"	YAMAHA's Support Software VIP+ User's Manual
Image sensor	Manual for each image sensor

Additionally, the calibration method and some robot commands of this system are common to those of YAMAHA robot vision system iVY System.
Therefore, the general-purpose image sensor can be used in the same manner as iVY System.
For details about iVY System, see the YAMAHA Robot Vision System iVY System User's Manual.

About system configuration

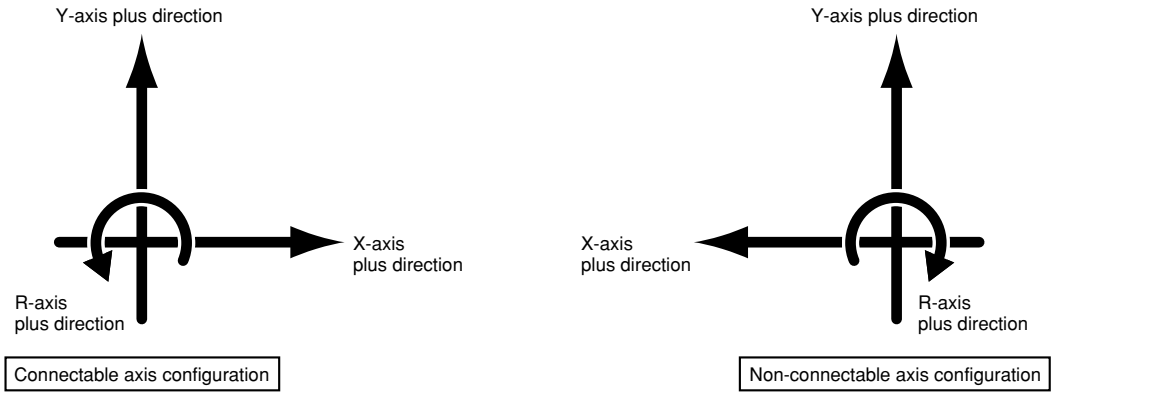
To use this system, it is necessary that the robot axis configuration is set as follows.

For SCARA robot

The standard coordinates of the SCARA robot need to be set so that the "Y plus" direction is 90 degrees counterclockwise to the "X plus" direction as shown in the figure below.
Additionally, it is necessary that the "R plus" direction is set to the counterclockwise rotation.

For Cartesian robot

The axis configuration of the Cartesian robot needs to be set so that the Y-axis plus direction is 90 degrees counterclockwise to the X-axis plus direction as shown in the figure below.
Additionally, for the robot with the R-axis, it is necessary that the R-axis plus direction is set to the counterclockwise rotation.



63001-T7-00

Connectable image sensor

This system applies only to an image sensor that satisfies the specifications shown below.

Communication method

RS-232C or Ethernet

* When connecting through the Ethernet, it is necessary to install the Ethernet network board in the robot controller. Additionally, when connecting through the Ethernet, the robot controller functions as a server. Therefore, it is necessary that the image sensor operates as a client.

Image capturing trigger

The image sensor can be controlled by sending and receiving a command character string.

Output setting

The response character string to the image capturing command should be returned and comma separated values of the response character string, the number of detections, and X and Y coordinates and angle of the image captured workpiece can be output.

* A delimiter can also be used for the character after the response character string.

Response character string	,	Number of detections	,	X (0)	,	Y (0)	,	Angle (0)	,	• • •	,	X (n)	,	Y (n)	,	Angle (n)	CR

Response character string	CR																
Number of detections	,	X (0)	,	Y (0)	,	Angle (0)	,	• • •	,	X (n)	,	Y (n)	,	Angle (n)	CR		

Safety precautions

Be sure to read the safety precautions shown below before use.

Before using this product, thoroughly read this manual and related manuals, and operate the product in a correct manner while carefully checking the safety.
The precautions stated in this manual relate to only this product. To ensure the safety of the user's whole system that includes this product, please take appropriate safety measures as required by the user's individual system.
This manual uses the following safety alert symbols and signal words to provide safety instructions that must be observed and to describe handling precautions, prohibited actions, and instructions. Make sure that you understand the meaning of each symbol and signal word, and then read this manual.

CAUTION

This indicates a potentially hazardous situation which, if not avoided, could result in minor or moderate injury, or physical damage to the equipment.

NOTE

Explains the key point in the operation in a simple and clear manner.

The instructions stated even in "CAUTION" may lead to serious results depending on the conditions. In any case, the instructions include important contents. So, be sure to strictly observe the instructions.
Please store this manual in a place where all concerned personnel can refer to it immediately and deliver it to the final user.

■ Design precautions

CAUTION

When the program execution stops halfway, the program executes the command that has been stopped again. For example, carefully check the re-execution of the program when using the arch motion of the MOVE command, relative movement commands, such as MOVEI command or DRIVEI command, or the communication command of the SEND command.

Warranty

For information on the warranty period and terms, please contact our distributor where you purchased the product.

■ This warranty does not cover any failure caused by:

1. Installation, wiring, connection to other control devices, operating methods, inspection or maintenance that does not comply with industry standards or instructions specified in the YAMAHA manual;
2. Usage that exceeded the specifications or standard performance shown in the YAMAHA manual;
3. Product usage other than intended by YAMAHA;
4. Storage, operating conditions and utilities that are outside the range specified in the manual;
5. Damage due to improper shipping or shipping methods;
6. Accident or collision damage;
7. Installation of other than genuine YAMAHA parts and/or accessories;
8. Modification to original parts or modifications not conforming to standard specifications designated by YAMAHA, including customizing performed by YAMAHA in compliance with distributor or customer requests;
9. Pollution, salt damage, condensation;
10. Fires or natural disasters such as earthquakes, tsunamis, lightning strikes, wind and flood damage, etc;
11. Breakdown due to causes other than the above that are not the fault or responsibility of YAMAHA;

■ The following cases are not covered under the warranty:

1. Products whose serial number or production date (month & year) cannot be verified.
2. Changes in software or internal data such as programs or points that were created or changed by the customer.
3. Products whose trouble cannot be reproduced or identified by YAMAHA.
4. Products utilized, for example, in radiological equipment, biological test equipment applications or for other purposes whose warranty repairs are judged as hazardous by YAMAHA.

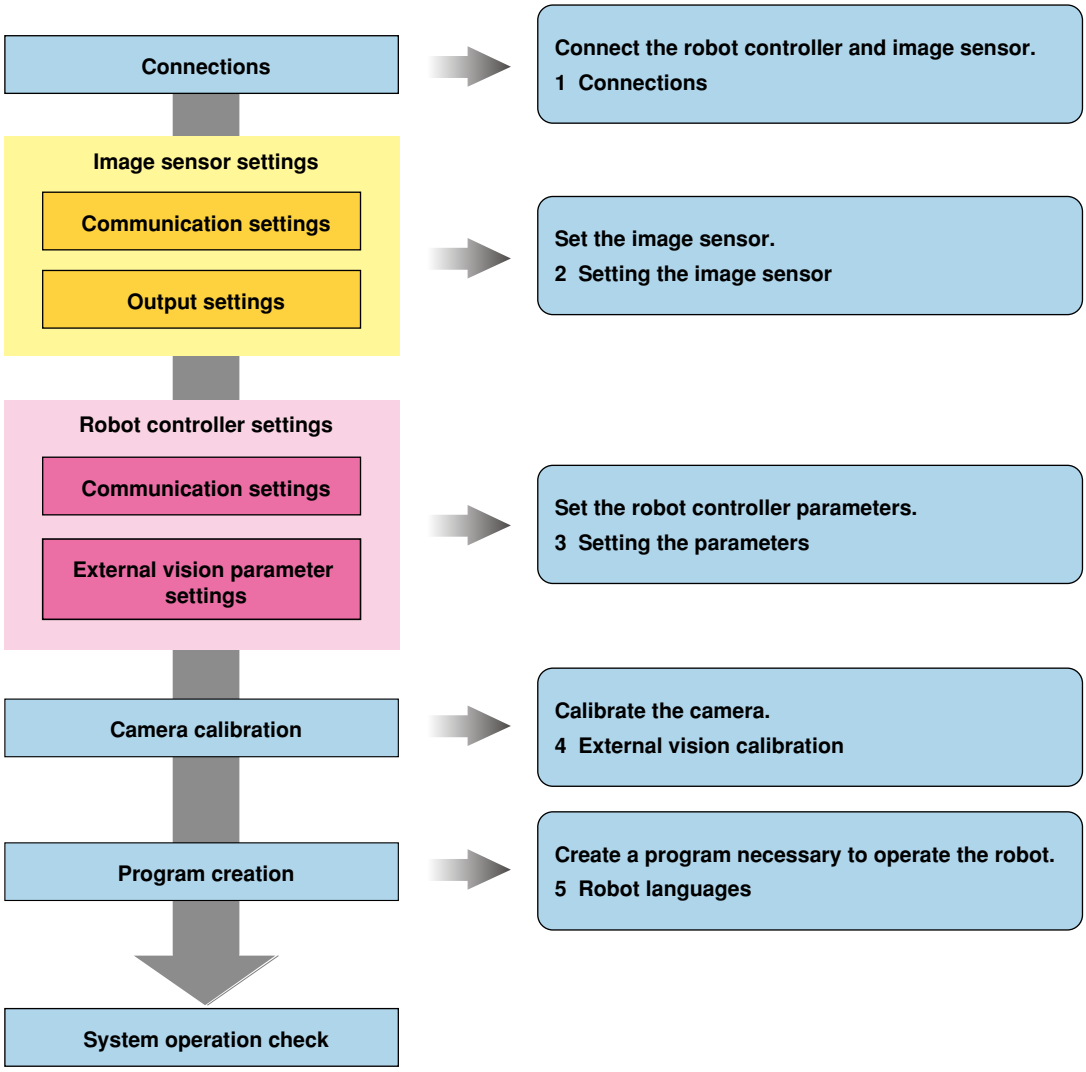
THE WARRANTY STATED HEREIN PROVIDED BY YAMAHA ONLY COVERS DEFECTS IN PRODUCTS AND PARTS SOLD BY YAMAHA TO DISTRIBUTORS UNDER THIS AGREEMENT. ANY AND ALL OTHER WARRANTIES OR LIABILITIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE ARE HEREBY EXPRESSLY DISCLAIMED BY YAMAHA. MOREOVER, YAMAHA SHALL NOT BE HELD RESPONSIBLE FOR CONSEQUENT OR INDIRECT DAMAGES IN ANY MANNER RELATING TO THE PRODUCT.

This manual does not serve as a guarantee of any industrial property rights or any other rights and does not grant a license in any form. Please acknowledge that we bear no liability whatsoever for any problems involving industrial property rights which may arise from the contents of this manual.

Constructing a system

The following describes how to construct a system.

Constructing a system



63002-T7-00

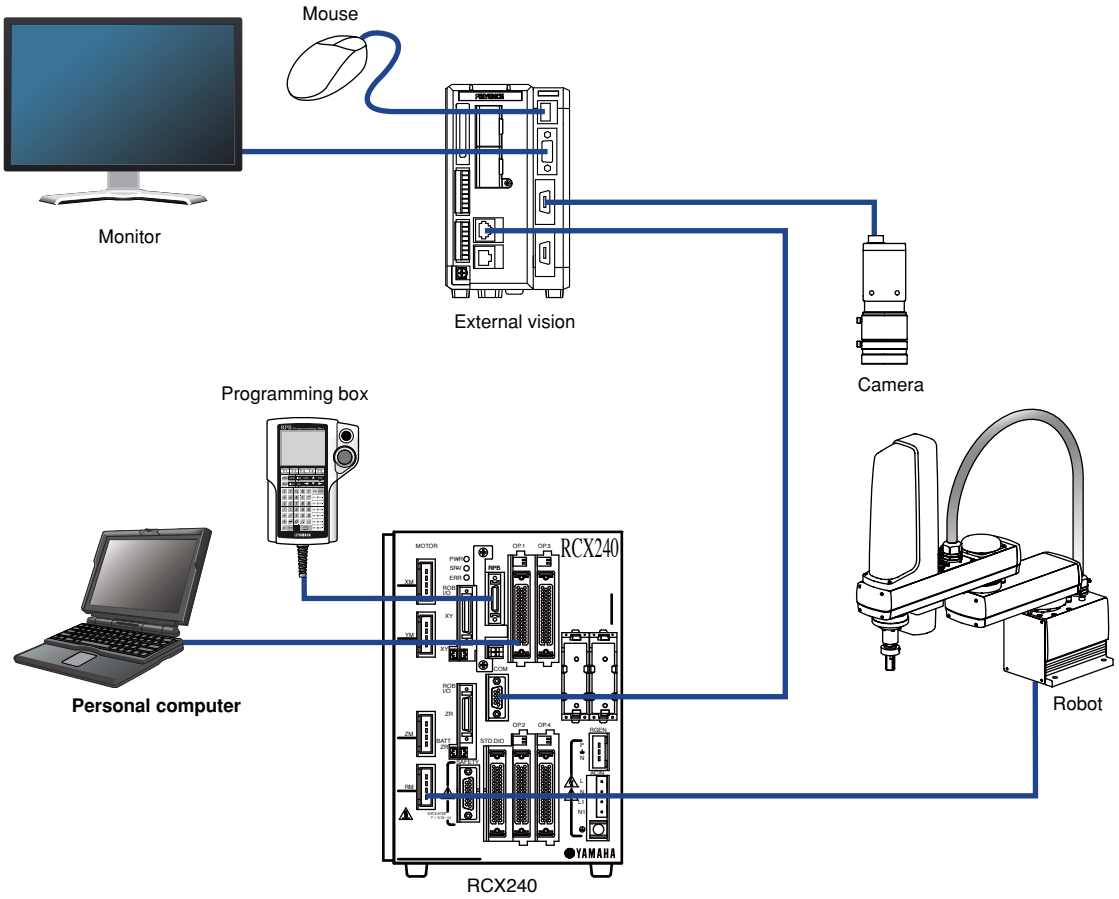
1. Connections

Connect the robot controller, image sensor, and personal computer.
For details about how to install the robot controller and image sensor, see relevant manuals.

MEMO

Connect the controller and personal computer through the Ethernet or RS-232C.
When connecting through the RS-232C, the communication cable connection destination needs to be changed between the program editing and robot operation.
When connecting through the Ethernet, it is necessary to install the Ethernet network board in the controller.

Connection diagram



63003-T7-00

2. Setting the image sensor

2.1 Communication settings

Match the communication settings of the image sensor to those of the robot controller.
For details about how to make the settings, see the manual for image sensor.

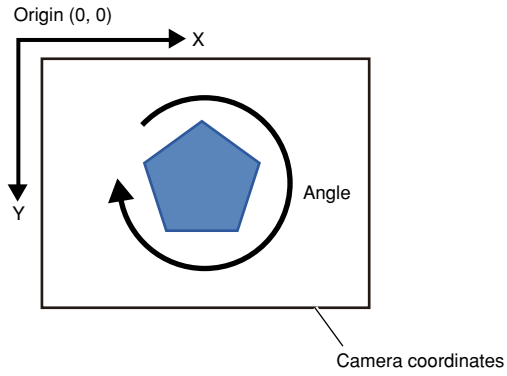
TIP

When connecting through the Ethernet, the robot controller functions as a server.
Therefore, it is necessary that the image sensor operates as a client.

2.2 Coordinate settings

Set the image sensor origin, X and Y coordinates, and angle direction as shown in the figure below.

Setting the camera coordinates and X and Y coordinates



63004-T7-00

2.3 Output settings

The image captured results of the image sensor are output.

- **Output items**

Item name	Description
Response character string	Response character string of the image sensor to the image capturing command
Number of detections	Number of workpieces detected during image capturing
X (n)	X-coordinate value of the detected workpiece (n) in the camera coordinate system (Unit: pix)
Y (n)	Y-coordinate value of the detected workpiece (n) in the camera coordinate system (Unit: pix)
Angle (n)	Angle of the detected workpiece in the camera coordinate system (Unit: °)

- **Other symbols**

Data separator	Comma ","
Delimiter	CR or CR/LF

- **Format**

Output comma separated data in any of the formats shown below.

Response character string	,	Number of detections	,	X (0)	,	Y (0)	,	Angle (0)	,	• • •	,	X (n)	,	Y (n)	,	Angle (n)	CR

Response character string	CR
Number of detections	, X (0) , Y (0) , Angle (0) , • • • , X (n) , Y (n) , Angle (n) CR

Separate each data by a comma.

TIP

The response character string may vary depending on the image sensor.
Either a comma or delimiter can be used only for the data separator after the response character string.
Be sure to output the workpiece position information (X, Y, and angle) for the number of workpiece detections.
Set each data so that it becomes a character string containing less than 20 characters.

■ Output example (The number of workpiece detections is 2.)

Manufacturer	Model name	Output example
KEYENCE	CV-5000	T1,02,+00498.777,+00365.239,+155.096,+00434.443,+00267.915,-027.088
	CV-X100	T1 0002,+00268.465,+00150.117,-00009.146,+00224.879,+00258.308,-00009.127
OMRON	FZ4	OK 0002,+00268.465,+00150.117,-00009.146,+00224.879,+00258.308,-00009.127
COGNEX	In-Sight®	1 2,315.667,126.415,0.717,128.363,481.136,1.637

TIP

For details about output settings, see "7.1 Examples of controller and image sensor connections".

3. Setting the parameters

3.1 Communication settings

Match the communication settings of the robot controller to those of the image sensor.
For details about communication settings, see the RCX240 User's Manual.

3.2 External vision parameter settings

Set the external vision parameters according to the specifications of the image sensor to be connected.

3.2.1 External vision parameter list

No.	Name Programming box display	Meaning	Input range	Initial value	Unit
1	Trigger character string Trigger Command	Set the image capturing command that is sent to the image sensor when executing the EXSEARCH command.	0 to 8 characters	-	-
2	Response character string Response Command	Set the response character string from the image sensor to the image capturing command.	0 to 8 characters	-	-
3	External vision resolution X EX Cam FOV X	Set the camera resolution in the X-axis direction of the image sensor to be used.	0 to 10000	640	[pix]
4	External vision resolution Y EX Cam FOV Y	Set the camera resolution in the Y-axis direction of the image sensor to be used.	0 to 10000	480	[pix]
5	Search timeout TimeOut	Set a period of the timeout time during execution of the EXSEARCH command.	0 to 600	100	[×100ms]
6	Communication port Connection Port	Set the port used to communicate with the image sensor.	CMU/ETH	CMU	-

3.2.2 External vision parameter details

No.1	Trigger character string	Input range	Initial value	Unit
		0 to 8 characters	-	-

Function

Sets the image capturing command that is sent to the image sensor when executing the EXSEARCH command.

Description

When executing the EXSEARCH command, the character string set by this parameter is sent to the image sensor.
Set the image capturing command of the image sensor.
Up to 8 characters can be set for this character string. Additionally, a blank character cannot be used.

No.2	Response character string	Input range	Initial value	Unit
		0 to 8 characters	-	-

Function

Sets the response character string from the image sensor to the image capturing command.

Description

When sending the image capturing command to the image sensor, the response is returned from the image sensor.
Set the character string that is sent from the image sensor when the image sensor accepts the image capturing command successfully.
If a character string other than that set by this command is sent from the image sensor, the search error is given.
Up to 8 characters can be set for this character string. Additionally, a blank character cannot be used.

No.3	External vision resolution X	Input range	Initial value	Unit
		0 to 10000	640	[pix]

No.4	External vision resolution Y	Input range	Initial value	Unit
		0 to 10000	480	[pix]

Function

Sets the camera resolutions in the X- and Y-axis directions of the image sensor to be used.

Description

Set the camera resolutions in the X- and Y-axis directions of the image sensor to be connected to the robot controller.
The settable range is 0 to 10000 [pix].

No.5	Search timeout	Input range	Initial value	Unit
		0 to 600	100	[100 ms]

Function

Sets the timeout time during execution of the EXSEARCH command.

Description

If the response is not returned from the image sensor within the set period of time after executing the EXSEARCH command, the timeout error is given. When the set value is 0, the search timeout process is not performed.
Set an appropriate value by considering the image capturing time of the image sensor.

No.6	Communication port	Input range	Initial value	Unit
		CMU/ETH	CMU	-

Function

Sets the port used to communicate with the image sensor.

Description

When connecting the image sensor through the RS-232C, specify "CMU". When connecting through the Ethernet, specify "ETH".

3.2.3 Editing an external vision parameter

This section describes how to edit parameters related to the external vision. To edit external vision parameters, use the programming box.

Step 1 ***Select "SYSTEM>OPTION".***

Step 2 ***Press F5 (EX CAM).***

The setting items related to the external vision will appear.

64001-T7-00

Step 3 ***Select an external vision number you want to edit.***

Use the cursor keys (▲ / ▼) to select a desired number from EXCAM1 to EXCAM4, and press F1 (EDIT).

When the external vision parameter has already been set, "SET" is displayed.

64002-T7-00

Step 4 ***Enter a value.***

Use the cursor keys (▲ / ▼) to move the cursor to an item, in which you want to enter a value.
Enter a character string or value, and press the ENTER key.

- Values you can enter are 0 to 9 and A to Z.
- For Trigger Command and Response Command, enter a character string containing 8 or less characters.
- For EX Cam FOV X, EX Cam FOV Y, and TimeOut, enter a value within its input range.
- For Connection Port, select F1 (CMU) or F2 (ETH).

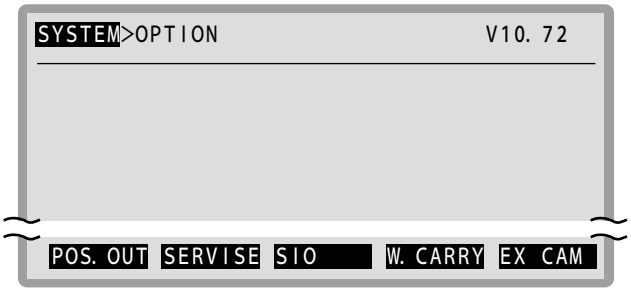
* For Connection Port, the value is set when pressing the function key.

Repeat operation steps shown above to enter values in all items.

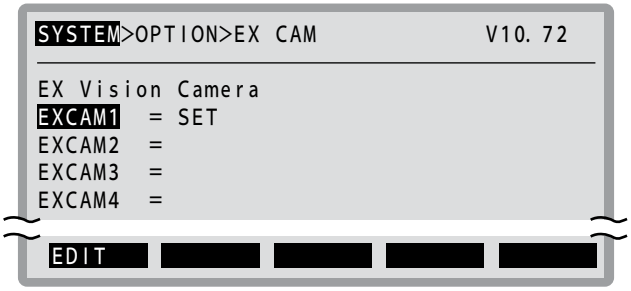
64003-T7-00

Step 5 ***Press ESC to exit the parameter editing.***

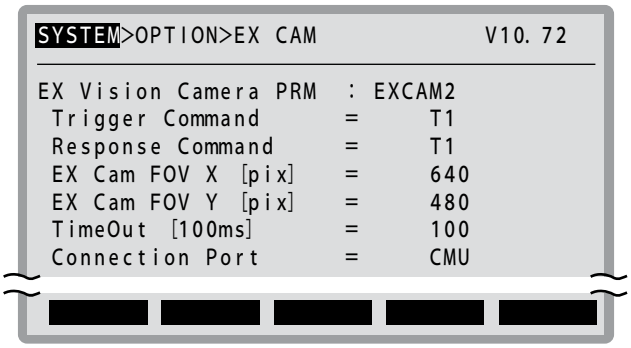
Step 2 **Option setting**



Step 3 **Selecting an external vision number**



Step 4 **Setting the external vision**


SYSTEM>OPTION>EX CAM V10. 72
EX Vision Camera PRM : EXCAM2
Trigger Command = T1
Response Command = T1
EX Cam FOV X [pix] = 640
EX Cam FOV Y [pix] = 480
TimeOut [100ms] = 100
Connection Port = CMU

3.2.4 Copying an external vision parameter

This section describes how to copy an external vision parameter.

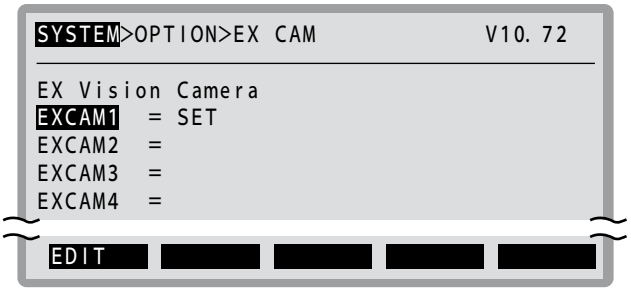
Step 1 ***Select "SYSTEM>OPTION>EX CAM".***

Step 2 ***Select an external vision parameter you want to copy.***

Use the cursor keys (▲ / ▼) to select an external vision parameter you want to copy.
In the items, for which the external vision parameter has already been set, "SET" is displayed.

64004-T7-00

Step 2 **Selecting a parameter you want to copy**

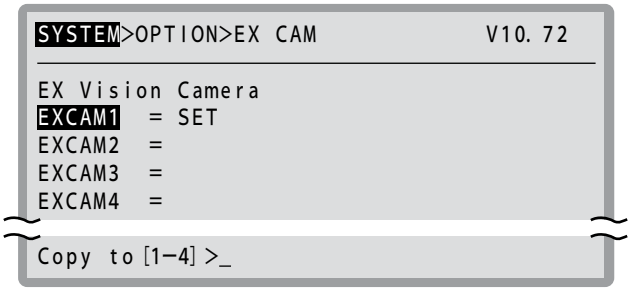


Step 3 ***Press F6 (COPY).***

The message, "Copy to (1-4)>", will appear on the guide line.
Press 1 to 4 to select a copy destination number, and press ENTER.
The confirmation message will appear on the guide line.

64005-T7-00

Step 3 **Entering a copy destination**

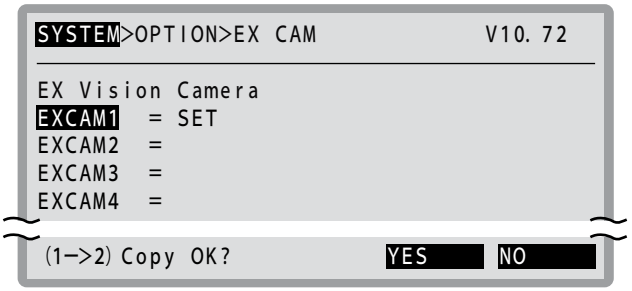


Step 4 ***Press F4 (YES) to start the copy process.***

The external vision parameter is then copied. If you do not copy the parameter, press F5 (NO).

64006-T7-00

Step 4 **Confirming the copy execution**



3.2.5 Erasing an external vision parameter

This section describes how to erase an external vision parameter.

Step 1 ***Select "SYSTEM>OPTION>EX CAM".***

Step 2 ***Select an external vision parameter you want to erase.***

Use the cursor keys (▲ / ▼) to select an external vision parameter you want to erase.
In the items, for which the external vision parameter has already been set, "SET" is displayed.

64007-T7-00

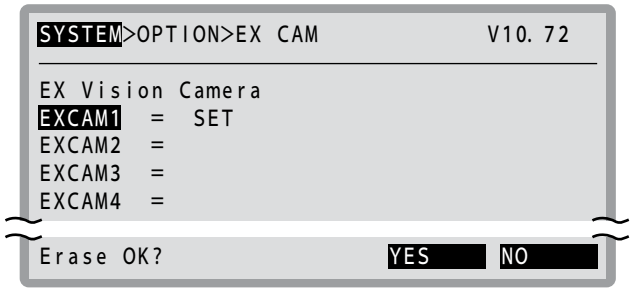
▶ **Step 2** **Selecting a parameter you want to erase**

Step 3 ***Press F7 (ERASE).***

The confirmation message will appear on the guide line.
If you want to erase the parameter, press F4 (YES).
If you do not erase the parameter, press F5 (NO).

64008-T7-00

▶ **Step 3** **Confirming the erase execution**



4. External vision calibration

This section describes how to calibrate the external vision.
The calibration is a work necessary to match the coordinates (camera coordinates) of the image captured by the camera to the robot coordinates.
The calibration of the external vision is required when constructing a system for the first time or when the positional relationship between the camera and robot changes (the camera deviates).
Up to four external vision calibration data can be stored.
When the distance between the workpiece and camera is different or when multiple cameras are installed, calibrate the external vision for each camera.

4.1 Executing the interactive external vision calibration

This section describes how to make the settings using the interactive external vision calibration.
The following describes the setting procedures using KEYENCE "CV-X100 series".

Step 1 *Put the calibration marks within the field-of-view of the camera.*

64009-T7-00

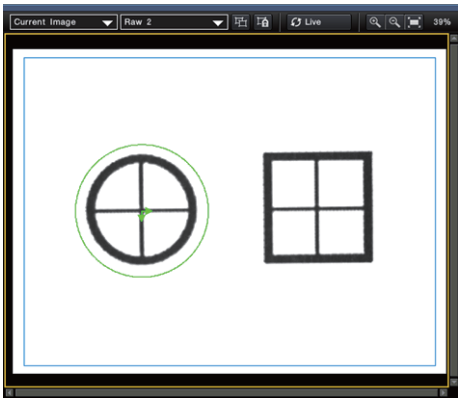
In this example, the circular mark and square mark are determined to mark 0 and mark 1, respectively.

* Make the distance between the calibration mark and camera identical with that at system startup.
* Do not move the mark until the end of the program execution.
* Arrange the marks so that they are as far away from each other as possible. If the marks are arranged in the near distance, the coordinate conversion accuracy may decrease.
  Additionally, do not arrange the marks at four corners of the field-of-view of the camera. The mark image may be distorted depending on the lens to be used.

Step 2 *Set the tool of the image sensor so that the calibration marks are detected.*

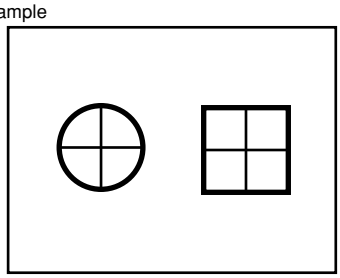
Set the tool so that mark 0 and mark 1 are detected.
For details about how to set the tool, see the manual for image sensor.

Step 1 Calibration marks

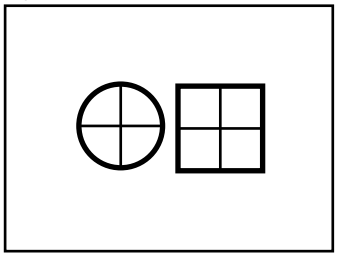


Examples of calibration mark arrangements

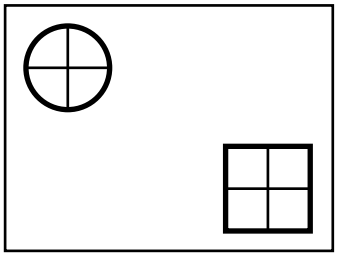
Correct example



Incorrect example



Marks are arranged in the near distance.



Marks are arranged at the corners of the field-of-view of the camera.

Step3 ***Select "MANUAL>VISION".***

Step4 ***Press F3 (EX WIZ).***

Make the interactive setting of the camera calibration.

64010-T7-00

Step5 ***Select a robot, to which the camera belongs.***

Press F1 (MAIN) or F2 (SUB) to select a robot, to which the camera to be calibrated belongs.

64011-T7-00

Step6 ***Select an external vision.***

Use F1 to F4 to select an external vision you want to calibrate.
To return the operation to the previous step, press F5 (<<PREV).

64012-T7-00

Step7 ***Select a calibration number.***

Use F1 (CALIB0) to F4 (CALIB3) to select a number, into which the calibration settings are registered.
To return the operation to the previous step, press F5 (<<PREV). (The operation returns to Step 6.)

64047-T7-00

Step8 ***Select a camera orientation.***

When the camera is installed on the SCARA robot or the Y-axis or Z-axis of the Cartesian axes, press F1 (2ND ARM).
When using the downward fixed camera, press F3 (DOWNWRD).
When using the upward fixed camera, press F4 (UPWRD).
To return the operation to the previous step, press F5 (<<PREV). (The operation returns to Step 7.)

64013-T7-00

CAUTION

When installing the camera on the robot, do not install it on the rotating part, such as the R-axis shaft or on the X-axis.

Step 4 **Starting the interactive setting of the camera calibration**

```
MANUAL>VISION                    20% [MG]   [S0H0X]

Select function
  F1:Camera Calibration Wizard
  F2:Edit Camera Calibration

  F3:EX Camera Calibration Wizard
  F4:Edit EX Camera Calibration

CAMWIZ  CAMEDT  EX WIZ  EX EDT
```

* If the iVY board is not installed in the robot controller, [CAMWIZ] (F1) and [CAMEDT] (F2) are not displayed.

Step 5 **Selecting a robot**

```
MANUAL>VISION>EX WIZ      20% [MG]   [S0H0X]

Select robot to which camera belongs
  F1:Main robot
  F2:Sub robot

MAIN  SUB
```

Step 6 **Selecting an external vision**

```
MANUAL>VISION>EX WIZ      20% [MG]   [S0H0X]

Select EX Camera to Calibrate

  F1-4:EX Vision Camrera No.  1-4

EXCAM1  EXCAM2  EXCAM3  EXCAM4  <<PREV
```

Step 7 **Selecting a calibration number**

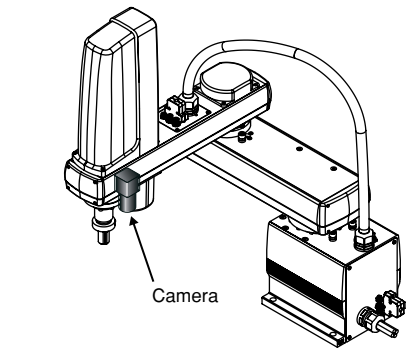
```
MANUAL>VISION>EX WIZ      20% [MG]   [S0H0X]

Select calibration number
  F1-4:Calibration No. 0-3

CALIB0  CALIB1  CALIB2  CALIB3  <<PREV
```

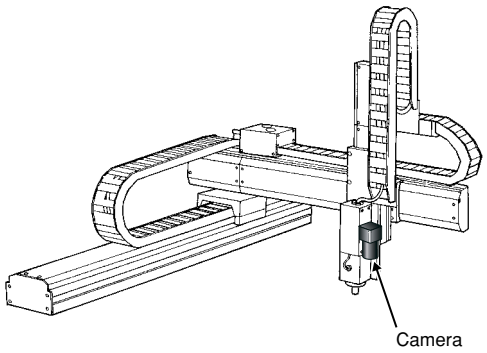
Step 8 **Selecting a camera orientation**

```
MANUAL>VISION>EX WIZ      20% [MG]   [S0H0X]

Select camera orientation
  F1:Mounted on 2nd arm

  F3:Fixed downward
  F4:Fixed upward

2ND ARM         DOWNWRD  UPWRD  <<PREV
```

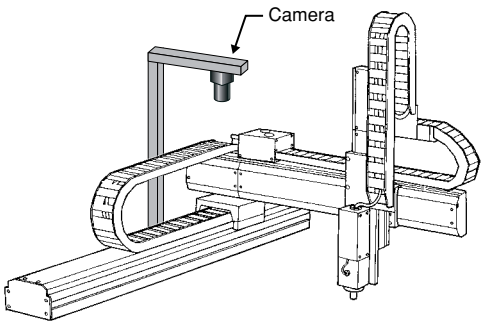
Examples of camera installations

When the camera is installed on the Y-axis or Z-axis of the robot, select F1 (2ND ARM).

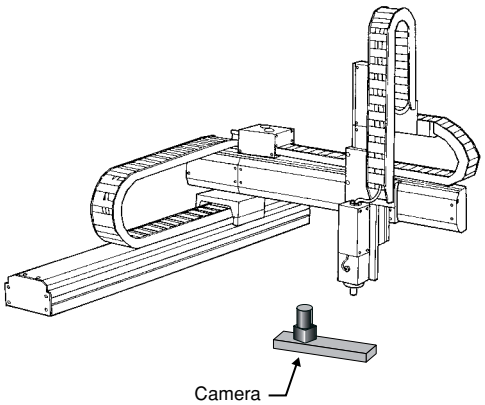




When the camera is secured to the non-movable part and it is faced downward, select F3 (DOWNWRD).



When the camera is secured to the non-movable part and it is faced upward, select F4 (UPWRD).



63005-T7-00

Step 9 *Check the setting contents.*

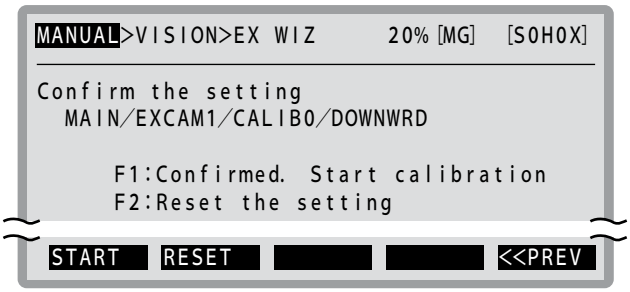
The setting contents until Step 8 will appear. When the setting contents have no problem and you start the calibration subsequently, press F1 *(START).*

To make the settings again, press F2 *(RESET). (You need to make the settings again from Step 5.)*

To return the operation to the previous step, press F5 *(<<PREV). (The operation returns to Step 8.)*

64017-T7-00

Step 9 Checking the setting contents



Step 10 *Arrange two calibration marks within the field-of-view of the camera.*

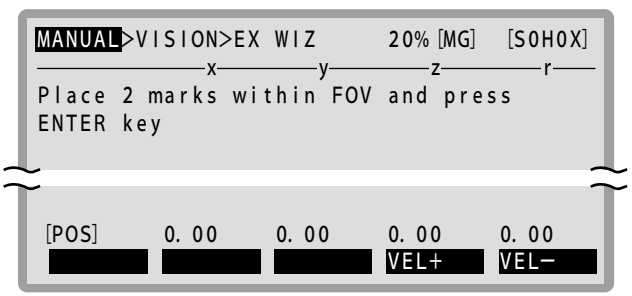
Check with the monitor of the image sensor that the calibration marks exist within the field-of-view, and then press the ENTER key on the programming box.

NOTE

After pressing the ENTER key, do not move the robot until the operation stated in Step 11 is completed. Otherwise, the calibration data may not be obtained correctly.

64014-T7-00

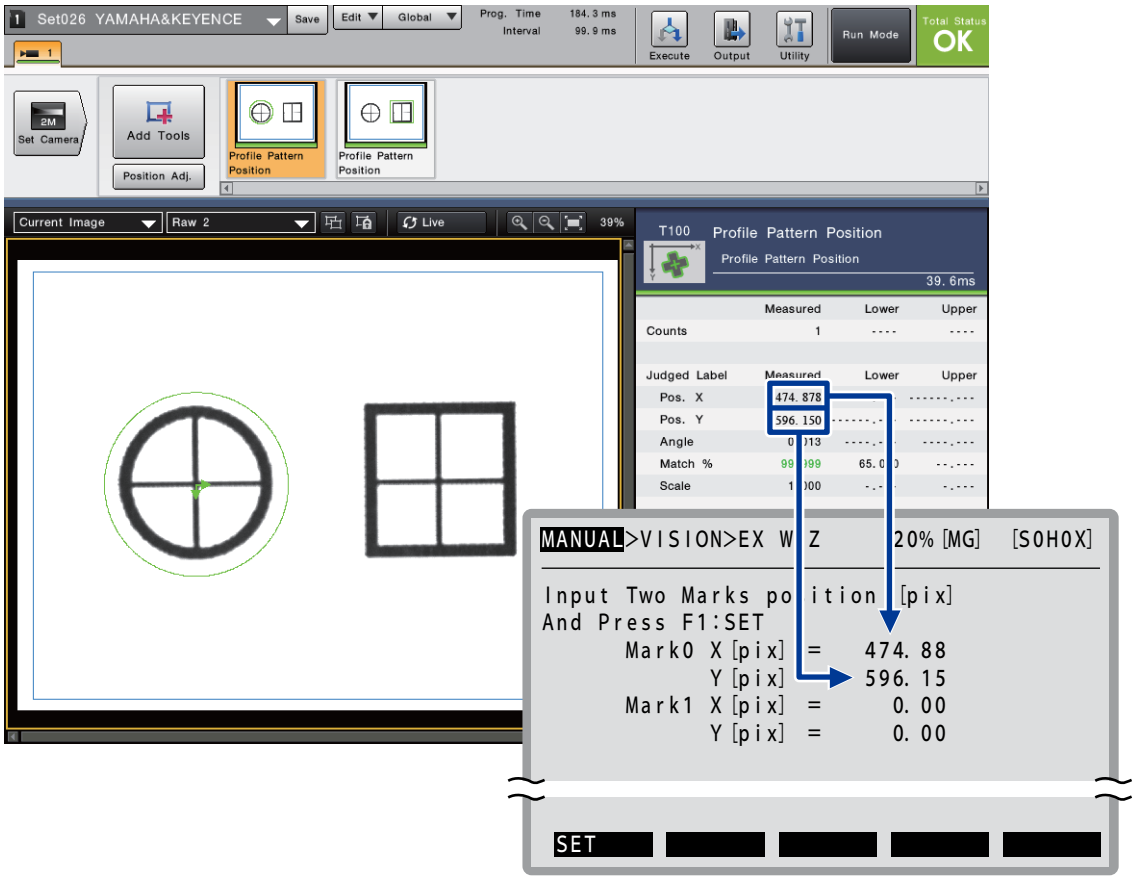
Step 10 Arranging the calibration marks within the field-of-view of the camera



Step 11 Set the camera coordinates of the fiducial marks.

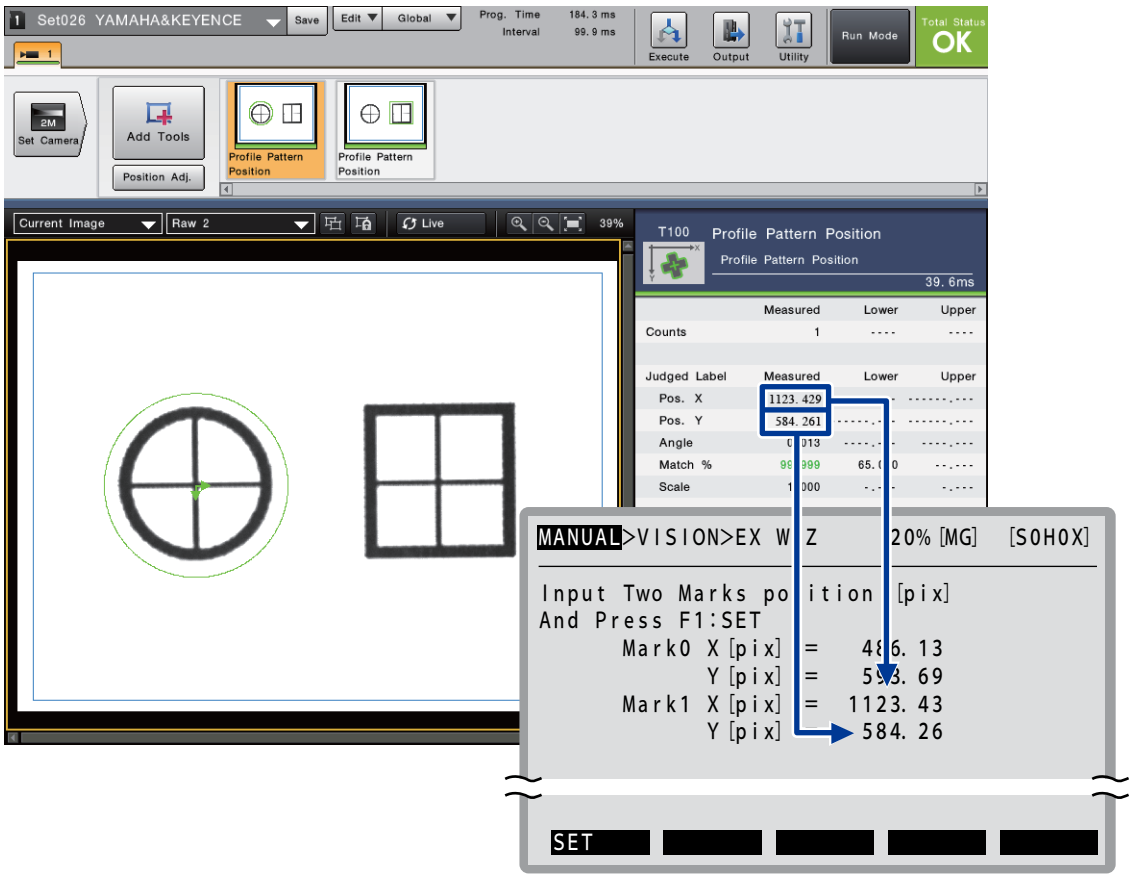
Capture the images of fiducial marks 0 and 1, and enter the measurement values of the fiducial marks obtained from the image sensor.
At this time, enter the values using "0 to 9" and ".".
After entering the values, press the ENTER key to set them.
After you have entered all values, press F1 *(SET).*

Setting the camera coordinates of fiducial mark 0



64015-T7-00

Setting the camera coordinates of fiducial mark 1



64016-T7-00

Step 12 Move the target robot to the fiducial mark 0 position, and press ENTER.

Move the tip of the target robot to the fiducial mark 0 position, and press ENTER.

To move the tip of the target robot, use the JOG key or press the emergency stop button on the programming box and manually move it in the emergency stop state.

When pressing ENTER, *the robot tip position (XY coordinates) is then set to Mrk0.*

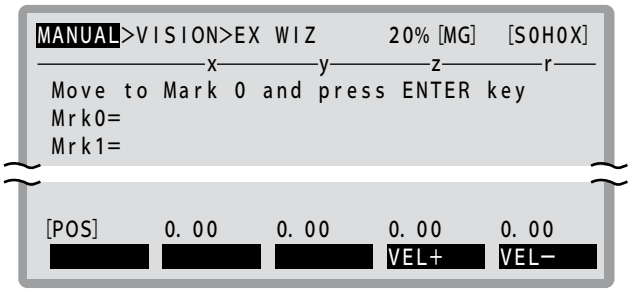
WARNING

- **WHEN MOVING THE ROBOT WITH THE JOG KEY, THE ROBOT OPERATES. SO, DO NOT ENTER THE ROBOT MOVEMENT RANGE TO PREVENT ANY HAZARD.**
- **WHEN MOVING THE ROBOT MANUALLY, BE SURE TO PUT THE OPERATION IN THE EMERGENCY STOP STATE BY PRESSING THE EMERGENCY STOP BUTTON ON THE PROGRAMMING BOX.**
  THE SERVO DOES NOT TURN ON FROM A VIEW POINT OF HARDWARE IN THE EMERGENCY STOP STATE.

NOTE

- When teaching the robot tip position coordinates in fiducial mark 0 (Mrk0) in pulses, they are converted into those in mm during setting.
- To change the manual movement speed when moving the robot with the JOG key, use F4 (VEL+), F5 (VEL-), F9 (VEL++), or F10 (VEL--).
- For the robot with the rotation axis, such as the SCARA robot, the rotation center when turning the rotation axis becomes the robot tip. When performing the calibration with the tool attached, set the hand so that the tool tip becomes the rotation center.

Moving to fiducial mark 0

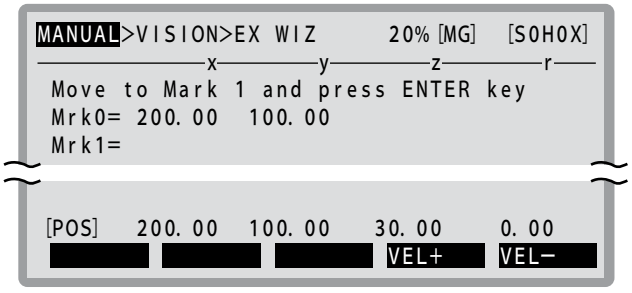


64018-T7-00

Step 13 *Move the target robot to the fiducial mark 1 position, and press* ENTER.

In the same manner as described in Step 12, move the tip of the target robot to the fiducial mark 1 position, and press ENTER.

Moving to fiducial mark 1


MANUAL>VISION>EX WIZ 20% [MG] [S0H0X]
x y z r
Move to Mark 1 and press ENTER key
Mrk0= 200.00 100.00
Mrk1=
[POS] 200.00 100.00 30.00 0.00
VEL+ VEL−

64019-T7-00

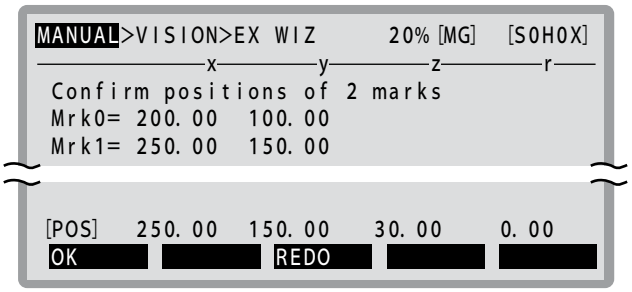
Step 14 *Make sure that two fiducial mark positions have no problem, and press* F1 *(OK).*

Check that the robot coordinate data of fiducial marks 0 and 1 you have set in Step 12 and Step 13 is correct.

When no problem is found, press F1 *(OK).*

When teaching the robot coordinate data of the fiducial marks again, press F3 *(REDO). (The operation returns to Step 12.)*

Checking the fiducial mark positions



64020-T7-00

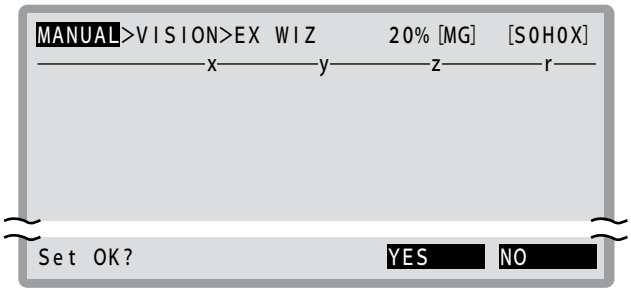
Step 15 ***Press F1 (YES) to register the camera calibration settings.***

The message, "Set OK?", will appear on the bottom line of the programming box.

To register the camera calibration settings, press F1 *(YES).*

To cancel the registration of the camera calibration settings, press F2 *(NO).*

Registering the camera calibration settings



64021-T7-00

4.2 Editing external vision calibration data

This section describes how to edit external vision calibration data.

Step 1 ***Select "MANUAL>VISION>EX EDT".***

64022-T7-00

Step 2 ***Select a calibration number.***

Use the cursor keys (▲ / ▼ *) to select a calibration number you want to edit. In the items, for which the camera calibration has already been set, "SET" is displayed.*

64023-T7-00

Step 3 ***Press F1 (EDIT).***

Step 4 ***Select a camera orientation.***

When the camera is installed on the SCARA robot or the Y-axis or Z-axis of the Cartesian axes, press F1 *(2ND ARM).*

When using the downward fixed camera, press F3 *(DOWNWRD).*

When using the upward fixed camera, press F4 *(UPWRD).*

When the camera orientation has already been set, the current setting state is displayed at the right end of the 3rd line on the screen.

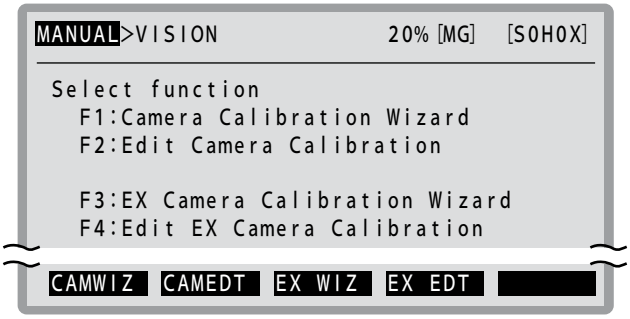
When selecting the camera orientation, the detail edit screen will appear.

64024-T7-00

CAUTION

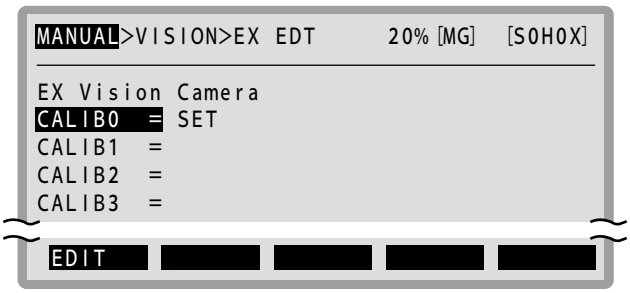
When installing the camera on the robot, do not install it on the rotating part, such as the R-axis shaft or on the X-axis.

▶ **Step 1** **Editing calibration data**

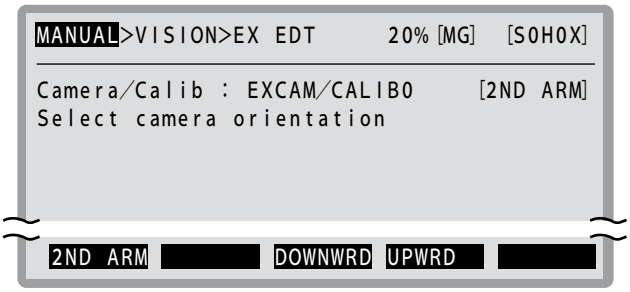


* If the iVY board is not installed in the robot controller, [CAMWIZ] (F1) and [CAMEDT] (F2) are not displayed.

▶ **Step 2** **Selecting a calibration number**



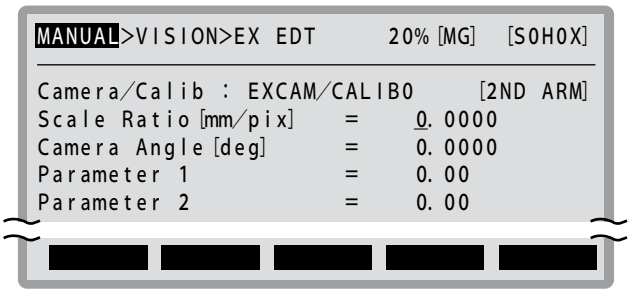
▶ **Step 4** **Selecting a camera orientation**



Step5 ***Use the cursor keys (▲ / ▼) to move the cursor to a position where you want to change the data.***

64025-T7-00

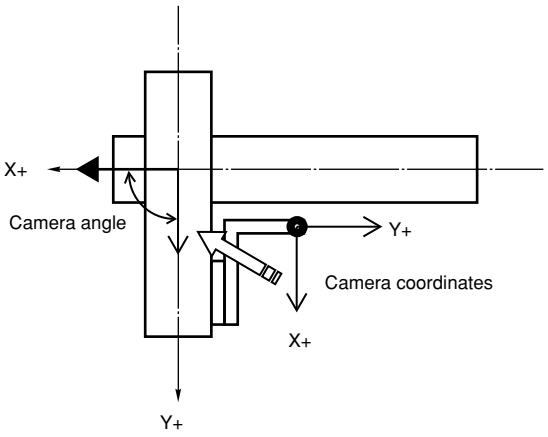
Step 5 **Editing camera calibration data**


MANUAL>VISION>EX EDT 20% [MG] [S0H0X]
Camera/Calib : EXCAM/CALIB0 [2ND ARM]
Scale Ratio [mm/pix] = 0.0000
Camera Angle [deg] = 0.0000
Parameter 1 = 0.00
Parameter 2 = 0.00

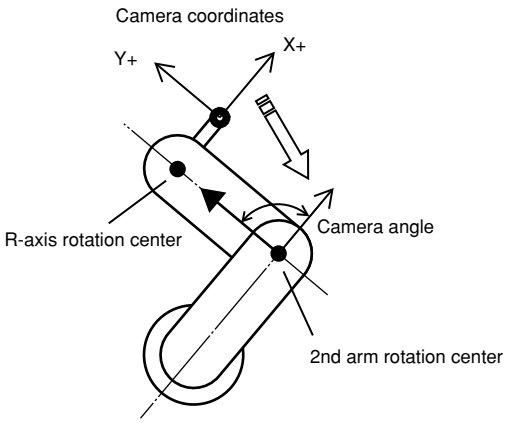
Step6 ***Use 0 to 9, and . to enter a value.***

The meaning of each item is as follows.

- **Scale Ratio [mm/pix]**
  Ratio of conversion from the camera coordinates to the robot coordinates
  Specify how many millimeters per pixel. The set value must be 0.0001mm/pix or more.
- **Camera Angle [deg]**
  The meaning of this item may vary depending on the robot setting and camera orientation.
  <Fixed camera>
  Camera installation angle to the robot coordinates
  <Camera is installed on the arm of the Cartesian robot.>
  Camera installation angle to the robot coordinates
  <Camera is installed on the arm of the SCARA robot.>
  Camera installation angle to the 2nd arm



Camera is installed on the arm of the Cartesian robot.



Camera is installed on the arm of the SCARA robot.

63006-T7-00

- **Parameter 1/Parameter 2**

  The meaning of this item may vary depending on the robot setting and camera orientation.

  <Fixed camera>

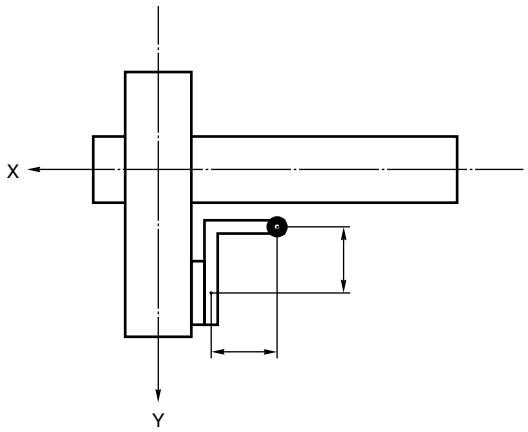
  Parameter 1 = X-coordinate of the robot expressing the center position of the camera field-of-view (Unit: mm)

  Parameter 2 = Y-coordinate of the robot expressing the center position of the camera field-of-view (Unit: mm)

  <Camera is installed on the arm of the Cartesian robot.>

  Parameter 1 = Offset amount from the robot tip to the center of the camera field-of-view in the X-direction (Unit: mm)

  Parameter 2 = Offset amount from the robot tip to the center of the camera field-of-view in the Y-direction (Unit: mm)

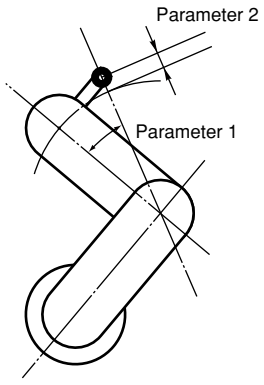


63007-T7-00

<Camera is installed on the arm of the SCARA robot.>

Parameter 1 = Number of offset pulses from the line connecting the root of the 2nd arm and the tip to the line connecting the root of the 2nd arm and the center of the camera field-of-view. Specify "+" value for the counterclockwise direction. (Unit: Pulse)

Parameter 2 = Difference between the length of the 2nd arm and the length of the line connecting the root of the 2nd arm and the center of the camera field-of-view. (Unit: mm)



63008-T7-00

4.3 Copying external vision calibration data

This section describes how to copy external vision calibration data.

Step 1 ***Select "MANUAL>VISION>EX EDT".***

64026-T7-00

Step 2 ***Select calibration data you want to copy.***

Use the cursor keys (▲ / ▼) to select calibration data you want to copy.
In the items, for which the calibration data has already been set, "SET" is displayed.

64027-T7-00

Step 3 ***Press F6 (COPY).***

The message, "Copy to (0-3)>", will appear on the guide line.

Press 0 to 3 to select a copy destination number, and press ENTER.

The confirmation message will appear on the guide line.

64028-T7-00

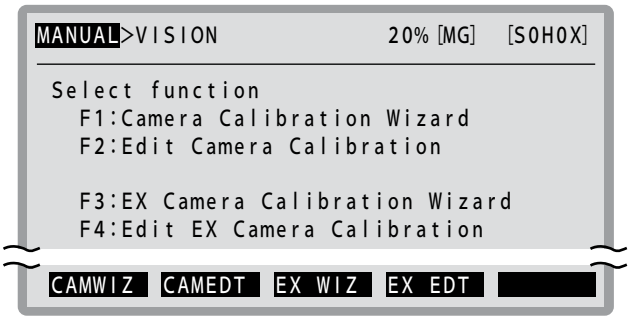
Step 4 ***Press F4 (YES) to start the copy process.***

The external vision calibration data is then copied.

If you do not copy the data, press F5 (NO).

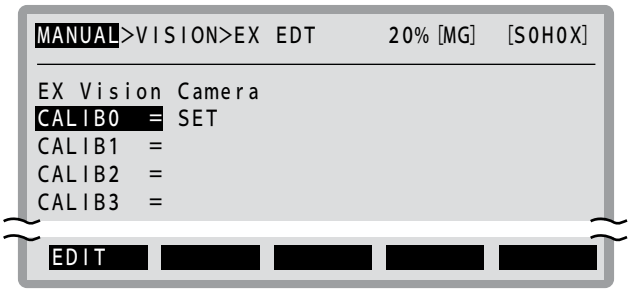
64029-T7-00

Step 1 Copying external vision calibration data

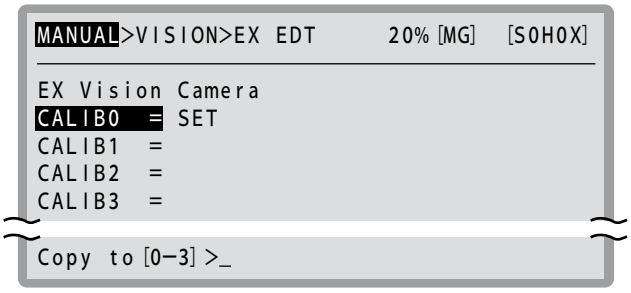


* If the iVY board is not installed in the robot controller, [CAMWIZ] (F1) and [CAMEDT] (F2) are not displayed.

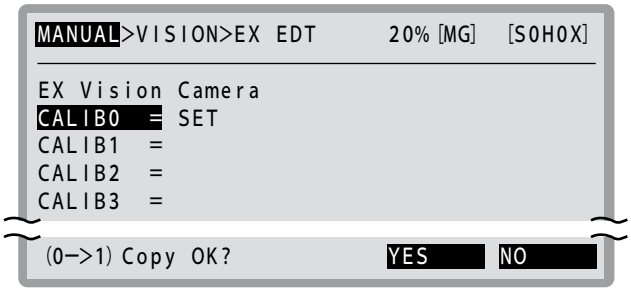
Step 2 Selecting calibration data you want to copy



Step 3 Entering a copy destination



Step 4 Confirming the copy execution



4.4 Erasing external vision calibration data

This section describes how to erase external vision calibration data.

Step 1 *Select "MANUAL>VISION>EX EDT".*

64030-T7-00

Step 2 *Select calibration data you want to erase.*

Use the cursor keys (▲ / ▼) to select calibration data you want to erase.
In the items, for which the calibration data has already been set, "SET" is displayed.

64031-T7-00

Step 3 *Press F7 (ERASE).*

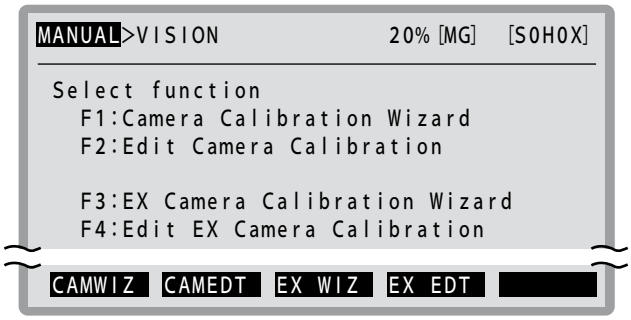
The confirmation message will appear on the guide line.

If you want to erase the data, press F4 (YES).

If you do not erase the data, press F5 (NO).

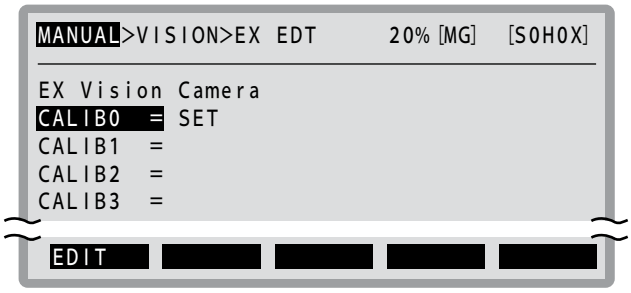
64032-T7-00

Step 1 Copying external vision calibration data

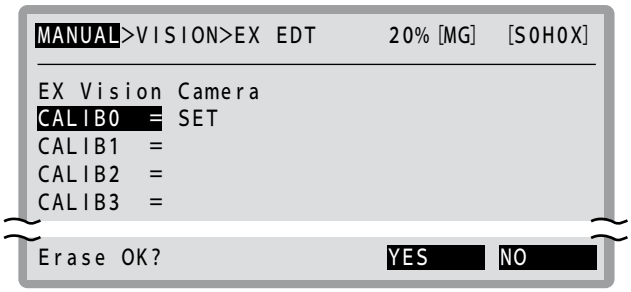


* If the iVY board is not installed in the robot controller, [CAMWIZ] (F1) and [CAMEDT] (F2) are not displayed.

Step 2 Selecting calibration data you want to erase



Step 3 Confirming the erase execution



5. Robot languages

This section describes the robot languages dedicated to the external vision system and common to the iVY system. For details about the robot language basic rules, such as command statement syntax, variable, and constant, and robot languages not described in this manual, see the YAMAHA RCX Series Programming Manual.
Additionally, when creating a program, be sure to also thoroughly read the YAMAHA RCX Series Programming Manual.

5.1 Robot language list

Language dedicated to external vision system

Language	Type	Function / Syntax
EXSEARCH	Command	Performs the image capturing of the image sensor to search for workpiece.
		EXSEARCH <External vision number> [, <Calibration number>]

Language common to iVY system

Language	Type	Function / Syntax
VGETCNT	Function	Acquires the number of detected workpieces after searching.
		VGETCNT
VGETPIX	Function	Acquires the pixel data of the specified array element number from the search result array in the point data format after searching.
		VGETPIX(<Array element number>)
VGETPOS	Function	Acquires the point data of the specified array element number from the search result array after searching.
		VGETPOS(<Array element number>)
VGETPOSX	Function	Acquires the X-coordinate value of the point data of the specified array element number from the search result array after searching.
		VGETPOSX(<Array element number>)
VGETPOSY	Function	Acquires the Y-coordinate value of the point data of the specified array element number from the search result array after searching.
		VGETPOSY(<Array element number>)

5.2 Robot language details

This section explains each robot language.

5.2.1 Language dedicated to external vision

This robot language is dedicated to the external vision.

EXSEARCH

EXSEARCH	EXSEARCH <External vision setting number> [, <Calibration number>]
	Captures the images using the external vision to search for workpiece.

Function

The image capturing command is sent to the external vision to search for workpiece, and then this search process result is received to store it into the search result array.
The image capturing command to be sent, received process result check, and communication port to be used are set using the external vision parameters. When specifying the calibration number, the camera coordinates are converted into the robot coordinates using the specified calibration data.

* The search results are stored into the search result array common to the iVY system. Additionally, "0" is stored into the scale and score values of the search result array.

Description

<External vision setting number>

Specify a parameter number for the external vision to be used for the search process. The number you can specify is any one of 1 to 4.
The external vision setting number can also be specified using the variable.

<Calibration number>

Specify a calibration number to be used for the search process. The number you can specify is any one of 0 to 3.
The calibration number can also be specified using the variable.
When the calibration number is not specified, the calibration data is not used.

Statement examples

EXSEARCH 1 ..... Uses the settings of external vision number 1 to search for workpiece using the image sensor.

EXSEARCH 2,3 ..... Uses the settings of external vision number 2 to search for workpiece using the image sensor, and makes the correction using calibration number 3.

5.2.2 Language common to iVY system

This section explains the robot language common to the iVY system.

VGETCNT

VGETCNT	VGETCNT
	Acquires the number of detected workpieces after searching.

Function

This function acquires the number of detected workpieces after searching.

Statement examples

```
EXSEARCH 1,2
PRINT VGETCNT ..... Outputs the number of detected workpieces to the programming box screen as a result of the search process.
C%=VGETCNT-1
FOR A%=0 TO C% ..... Repeats the process for the number of detected workpieces as a result of the search process.
  PRINT VGETPOS(A%)
NEXT A%
```

VGETPIX

VGETPIX	VGETPIX(<Array element number>)
	Acquires the pixel data of the specified array element number from the search result array after searching. (The value is acquired in the point data format.)

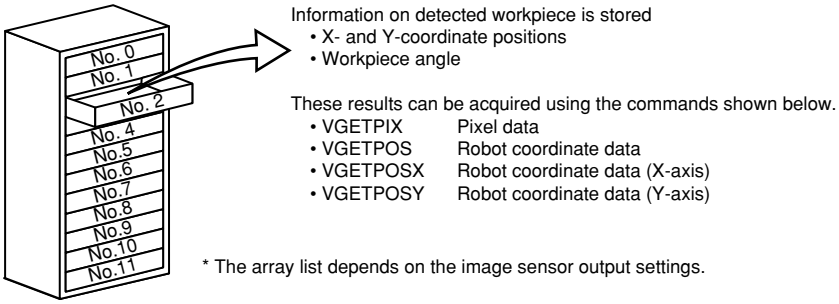
Function

This function acquires the pixel data from the search result array after searching. The pixel data is acquired from the specified array element of the search result array. The unit system of the pixel data to be acquired is pixel.

NOTE

- The search result array is an array that stores the search results after searching.

Search result array



- The point data to be acquired does not include any hand system flag.

MEMO

The array is, for example, just like a cabinet. A name (array element number) is put on each drawer that stores data. The same type data is stored into each drawer. In this manual, the drawer name is called "array element number", but it may also be called "subscript".

Description

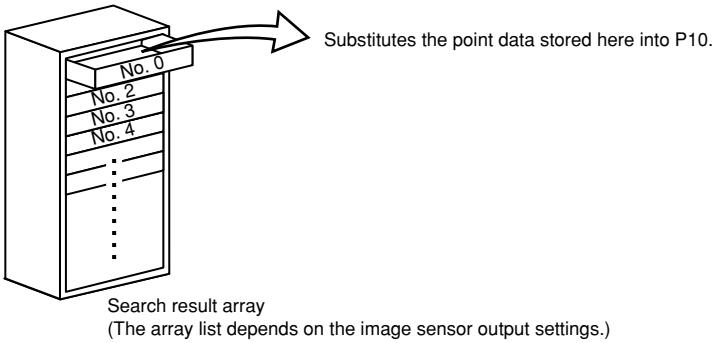
<Array element number>

This array element number is a number that specifies the array element of the search result array. Specify an array element number, the pixel data of which you want to acquire from the search result array. The number you can specify is any one of 0 to (VGETCNT-1). The array element number can also be specified using the variable.
The search result array is counted from number 0. The order of the array elements is a sequence that they are sorted by the robot coordinates by means of the sorting method specified by VSETSORT. (When the calibration number is not specified, this order becomes a sequence that the array elements are sorted by the pixel coordinates.)

Statement examples

P10=VGETPIX(0)..... Substitutes the pixel data of the 1st search result (array element number 0) into P10.

P10=VGETPIX(0)


No. 0
No. 2
No. 3
No. 4
Substitutes the point data stored here into P10.
Search result array
(The array list depends on the image sensor output settings.)

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NOTE

It is not allowed to write like MOVE P,VGETPIX(0).

VGETPOS

VGETPOS	VGETPOS(<Array element number>)
	Acquires the point data of the specified array element number from the search result array after searching.

Function

This function acquires the point data from the search result array after searching. The point data is acquired from the specified array element of the search result array. At this time, the Z-axis height of the robot during search execution is acquired as Z-axis point data. The unit system of the point data to be acquired is mm (Cartesian coordinate system).

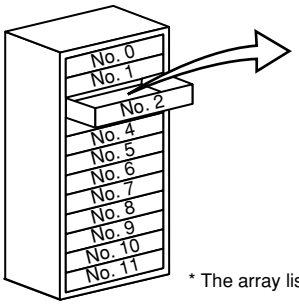
CAUTION

For the Z-axis data of the point data acquired by VGETPOS, the Z-axis height of the robot during search execution is acquired. Therefore, the position of the point data acquired by VGETPOS may vary depending on the robot position during search execution. When moving the robot to the position of the point data acquired by VGETPOS, carefully check the robot movement path so that the Z-axis does not collide with any object.

NOTE

- The search result array is an array that stores the search results after searching.

Search result array



Information on detected workpiece is stored
- X- and Y-coordinate positions
- Workpiece angle

These results can be acquired using the commands shown below.
- VGETPIX Pixel data
- VGETPOS Robot coordinate data
- VGETPOSX Robot coordinate data (X-axis)
- VGETPOSY Robot coordinate data (Y-axis)

* The array list depends on the image sensor output settings.

- When performing the search process using EXSEARCH without calibration settings, the error "20.80 : EX Vis calibration not set" may occur.
- The point data to be acquired does not include any hand system flag.

MEMO

The array is, for example, just like a cabinet. A name (array element number) is put on each drawer that stores data. The same type data is stored into each drawer. In this manual, the drawer name is called "array element number", but it may also be called "subscript".

Description

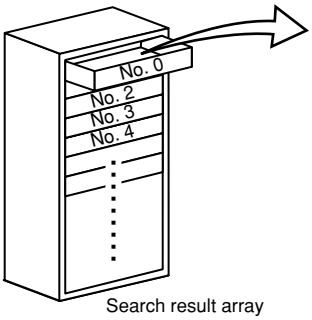
<Array element number>

This array element number is a number that specifies the array element of the search result array. Specify an array element number, the point data of which you want to acquire from the search result array. The number you can specify is any one of 0 to (VGETCNT-1). The array element number can also be specified using the variable.
The search result array is counted from number 0. The array list depends on the image sensor output settings.

Statement examples

P10=VGETPOS(0) .... Substitutes the point data of the 1st search result (array element number 0) into P10.

P10=VGETPOS(0)



Substitutes the point data stored here into P10.

Search result array
(The array list depends on the image sensor output settings.)

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```
C%=VGETCNT-1
FOR A%=0 TO C%
  MOVE P,VGETPOS(A%) ..... Moves to the point data positions of all search results in order.
NEXT A%
```

VGETPOSX/VGETPOSY

VGETPOSX **VGETPOSY**	VGETPOSX(<Array element number>) VGETPOSY(<Array element number>)
	Acquires the X- or Y-coordinate position of the workpiece of the specified array element number from the search result array after searching.

Function

This function acquires the X- or Y-coordinate position of the workpiece from the search result array after searching.
The X- or Y-coordinate position of the workpiece is acquired from the specified array element of the search result array.
The unit system of the data to be acquired is mm (Cartesian coordinate system).

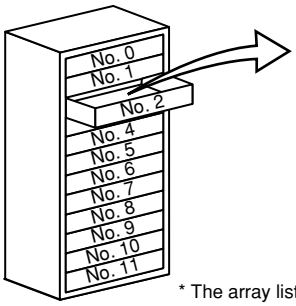
VGETPOSX ..... Acquires the X-coordinate position of the workpiece from the search result array.

VGETPOSY ..... Acquires the Y-coordinate position of the workpiece from the search result array.

NOTE

- The search result array is an array that stores the search results after searching.

Search result array



Information on detected workpiece is stored
- X- and Y-coordinate positions
- Workpiece angle

These results can be acquired using the commands shown below.
- VGETPIX Pixel data
- VGETPOS Robot coordinate data
- VGETPOSX Robot coordinate data (X-axis)
- VGETPOSY Robot coordinate data (Y-axis)

* The array list depends on the image sensor output settings.

- When performing the search process using EXSEARCH without calibration settings, the error "20.80 : EX Vis calibration not set" may occur.
- The point data to be acquired does not include any hand system flag.

MEMO

The array is, for example, just like a cabinet. A name (array element number) is put on each drawer that stores data. The same type data is stored into each drawer. In this manual, the drawer name is called "array element number", but it may also be called "subscript".

Description

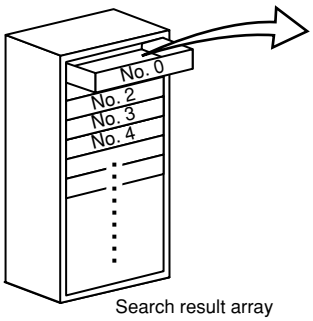
<Array element number>

This array element number is a number that specifies the array element of the search result array. Specify an array element number, the data of which you want to acquire from the search result array. The number you can specify is any one of 0 to (VGETCNT-1). The array element number can also be specified using the variable.
The search result array is counted from number 0. The array list depends on the image sensor output settings.

Statement examples

A=VGETPOSX(0)..... Substitutes the X-coordinate position of the workpiece of the 1st search result (array element number 0) into A.

A=VGETPOSX(0)



Substitutes the X-coordinate position of the workpiece stored here into variable A.

Search result array
(The array list depends on the image sensor output settings.)

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5.3 Sample program: Pick & place using search

Overview

The workpiece on the pallet is searched for by the cameras, and it is picked and placed at the workpiece supply destination.

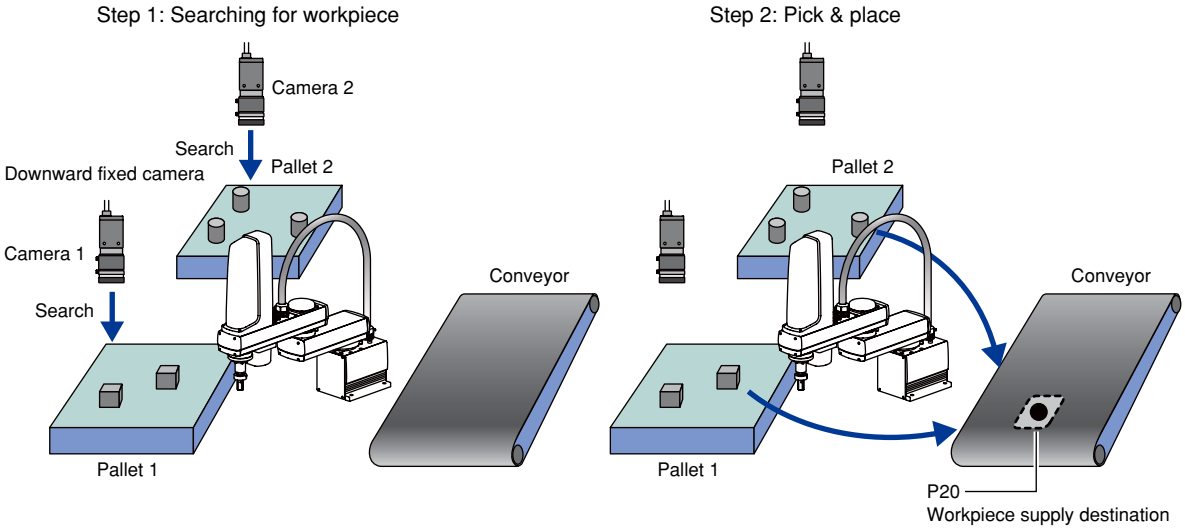
Step 1: The workpieces on the respective pallets are alternately searched for by camera 1 and camera 2.

Step 2: When the workpiece is detected, the robot holds the detected workpiece and places it at the workpiece supply destination (P20).

Step 3: Step 2 is repeated to move all detected workpieces. After all detected workpieces have been moved, the operation returns to step 1.

Pick & place using search

Overview of operation



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Preconditions

Robot motion

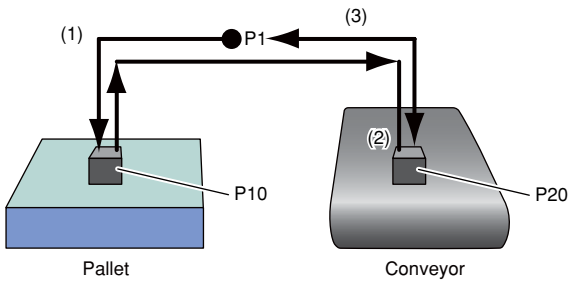
When the workpiece is detected, the robot operates as follows.

Step 1: Moves to the workpiece detection position (P10) using the arch motion.

Step 2: Holds the workpiece, moves to the workpiece supply destination (P20) using the arch motion, and releases the workpiece.
When multiple workpieces are detected, step 1 and step 2 are repeated until all workpieces are moved.

Step 3: Moves to the robot standby position (P1) using the arch motion.

Robot motion



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Points to be used

P1 ..... Standby position

P10 ..... Workpiece detection position (written in the program)

P20 ..... Workpiece supply position

● **Input/output signals to be used**

Contents of output signal		Output signal state	
		1	0
DO(20)	Workpiece pick & place instruction	Hold	Release

● **Others**

- It is preconditioned that each camera is set as shown below.

	Fixing method	External vision setting number	Calibration number	Communication method
Camera 1	Downward	1	0	ETH
Camera 2	Downward	2	1	CMU

- The Z-axis height of the robot at the workpiece holding position should be 50.00mm.
- The workpiece detection settings and output settings should be made on each camera correctly.
- The camera calibration of each camera should be performed correctly.

Sample program

```
*INIT:                  ·····Label definition (initial process)
  OFFLINE CMU           ·····Clears the buffer of the RS-232C port and changes the mode to the offline.
  OFFLINE ETH           ·····Clears the buffer of the Ethernet port and changes the mode to the offline.
 DELAY 100
  IF ETHSTS = 2 THEN    ·····Checks the buffer state of the Ethernet port.
    GOTO *INIT          ·····Jumps to label *INIT if data remains in the buffer.
  ENDIF
'
  COUNT% = 0            ·····Sets the initial value of the variable.
  MOVE P,P1,Z=0.0       ·····Moves to the standby position using the arch motion.
  WAIT ARM              ·····Waits for completion of the robot operation.
'
*MAIN:                  ·····Label definition (main routine)
  EXSEARCH 1,0          ·····Executes the search process of camera 1.
  IF VGETCNT > 0 THEN   ·····When workpiece is detected,
    GOSUB *PICKPLACE    ·····Jumps to label *PICKPLACE.
  ELSE
    PRINT "*** PALLET1:  WORK NOT FOUND ***"   ·····Displays the message if no workpiece is detected.
  ENDIF
'
  MOVE P,P1,Z=0.0       ·····Moves to the standby position using the arch motion.
  WAIT ARM              ·····Waits for completion of the robot operation.
'
  EXSEARCH 2,1          ·····Executes the search process of camera 2.
  IF VGETCNT > 0 THEN   ·····When workpiece is detected,
    GOSUB *PICKPLACE    ·····Jumps to label *PICKPLACE.
  ELSE                  ·····If no workpiece is detected,
    PRINT "*** PALLET2:  WORK NOT FOUND ***"   ·····Displays the message.
  ENDIF
'
  MOVE P,P1,Z=0.0       ·····Moves to the standby position using the arch motion.
  WAIT ARM              ·····Waits for completion of the robot operation.
'
  COUNT% = COUNT% + 1   ·····Counts the search execution cycles.
  IF COUNT% > 5 THEN    ·····Search is repeated 5 times.
    PRINT "*** PROGRAM END ***"   ·····Displays the message.
    ONLINE CMU          ·····Clears the buffer of the RS-232C port and changes the mode to the online.
    ONLINE ETH          ·····Clears the buffer of the Ethernet port and changes the mode to the online.
    HALT                ·····Exits the program.
  ENDIF                 ·····If the number of search cycles is less than 5,
'
  GOTO *MAIN            ·····Jumps to label *MAIN and repeats the search.
'
*PICKPLACE:             ·····Label definition (pick & place)
  FOR I% = 0 TO VGETCNT -1   ·····Repeats for the number of detected workpieces.
    P10 = VGETPOS(I%)   ·····Copies the workpiece detection position to P10.
    LOCZ(P10) = 50.0    ·····Sets the Z-axis position of P10 to 50.00mm.
    MOVE P, P10, Z=0.0  ·····Moves to P10 using the arch motion.
    DO(20) = 1          ·····Holds the workpiece.
    DELAY 100           ·····Waits for 100ms.
'
    MOVE P, P20, Z=0.0  ·····Moves to the workpiece supply position P20 using the arch motion.
    DO(20) = 0          ·····Releases the workpiece.
    DELAY 100           ·····Waits for 100ms.
  NEXT
  RETURN                ·····Returns to the main routine after all workpieces have been moved.
```

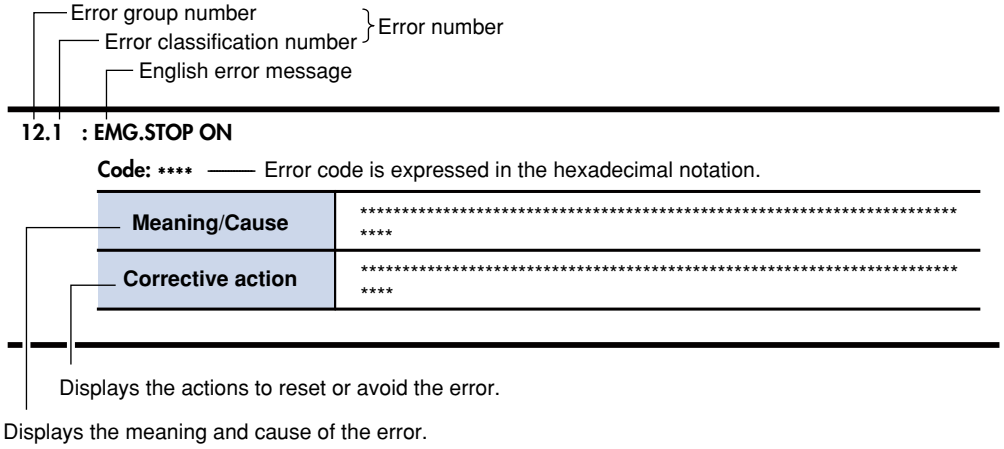
6. Troubleshooting

6.1. Error messages

This section describes the error messages related to the external vision system.
Errors with error number [20.80] or later are those dedicated to the external vision system.
Errors with error numbers [20.00] to [20.79] are those common to the iVY system. For details, see the iVY System User's Manual.
For details about errors other than those shown above, see relevant RCX240 Robot Controller User's Manual.
If an error occurs, relevant error message appears on the message line of the programming box.
For details about contents of each error message, see the list shown below.

[How to read the list]

The following shows the error message that appears on the screen.



NOTE

If the error cannot be solved even after taking the corrective action, contact your distributor.

20.80 : EX Vis calibration not set

Code : &H1450

Meaning/Cause	The external vision calibration number you have specified is incorrect.
Corrective action	Change the external vision calibration number you want to specify. Set the external vision calibration.

20.81 : EX_Vis EXCamera not set

Code : &H1451

Meaning/Cause	The external vision parameter setting number you have specified is incorrect.
Corrective action	Change the external vision parameter setting number you want to specify. Set the external vision parameters.

20.82 : EX Vis format error

Code : &H1452

Meaning/Cause	The output format of the external vision is incorrect.
Corrective action	Check the output settings of the external vision.

20.83 : EX Vis response command miss match

Code : &H1453

Meaning/Cause	The command is not sent to the external vision correctly.
Corrective action	Change the "response character string" of the external vision parameters. Check the external vision state. Check the connection settings between the robot controller and external vision.

20.84 : EX Vis work count error

Code : &H1454

Meaning/Cause	The number of workpiece detections is beyond the detectable range.
Corrective action	Change the detection settings of the external vision. Check the output format of the external vision.

20.85 : EX Vis work count miss match

Code : &H1455

Meaning/Cause	The number of workpiece detections varies from the number of receive data (X,Y,θ).
Corrective action	Check the output format of the external vision.

20.86 : EX_Vis search timeout

Code : &H1456

Meaning/Cause	The EXSEARCH command terminates due to timeout.
Corrective action	Change the timeout settings. Check the external vision state.

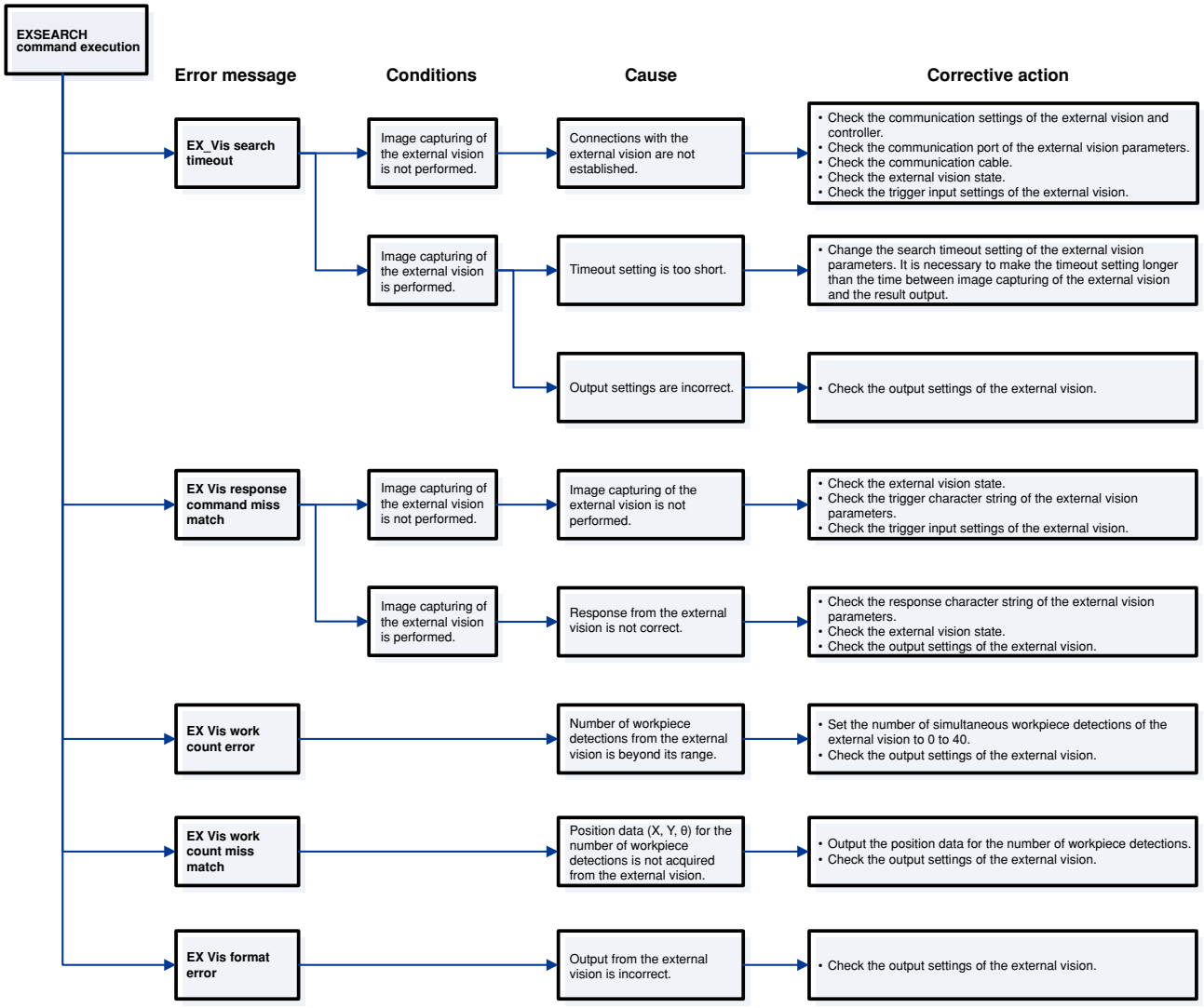
20.87 : EX_Vis calib.data destroyed

Code : &H1457

Meaning/Cause	An error occurs in the external vision calibration data.
Corrective action	Contact your distributor with details of the problem.

6.2 Actions to be taken if the communication fails.

If an error occurs during execution of the EXSEARCH command, check the communication settings or output settings while referring to the flow shown below.


EXSEARCH command execution
Error message
Conditions
Cause
Corrective action
EX_Vis search timeout
Image capturing of the external vision is not performed.
Connections with the external vision are not established.
• Check the communication settings of the external vision and controller.
• Check the communication port of the external vision parameters.
• Check the communication cable.
• Check the external vision state.
• Check the trigger input settings of the external vision.
Image capturing of the external vision is performed.
Timeout setting is too short.
• Change the search timeout setting of the external vision parameters. It is necessary to make the timeout setting longer than the time between image capturing of the external vision and the result output.
Output settings are incorrect.
• Check the output settings of the external vision.
EX Vis response command miss match
Image capturing of the external vision is not performed.
Image capturing of the external vision is not performed.
• Check the external vision state.
• Check the trigger character string of the external vision parameters.
• Check the trigger input settings of the external vision.
Image capturing of the external vision is performed.
Response from the external vision is not correct.
• Check the response character string of the external vision parameters.
• Check the external vision state.
• Check the output settings of the external vision.
EX Vis work count error
Number of workpiece detections from the external vision is beyond its range.
• Set the number of simultaneous workpiece detections of the external vision to 0 to 40.
• Check the output settings of the external vision.
EX Vis work count miss match
Position data (X, Y, θ) for the number of workpiece detections is not acquired from the external vision.
• Output the position data for the number of workpiece detections.
• Check the output settings of the external vision.
EX Vis format error
Output from the external vision is incorrect.
• Check the output settings of the external vision.

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7. Appendixes

7.1 Examples of controller and image sensor connections

This section describes examples of connections with the image sensors shown below.

- KEYENCE CV-X100 series
- OMRON FZ4 series, FQ-M series
- COGNEX EZ series, InSight series

KEYENCE CV-X100 series, OMRON FZ4 series, COGNEX EZ series, and InSight series are connected through the RS-232C. OMRON FQ-M series are connected through the Ethernet.
For details about how to operate each image sensor, see relevant manual.
Note that the contents of this manual are those when the references were prepared and may slightly differ from the actual displays and contents.

7.1.1 KEYENCE CV-X100 series

The following describes an example of connections with KEYENCE image sensor "CV-X100 series".

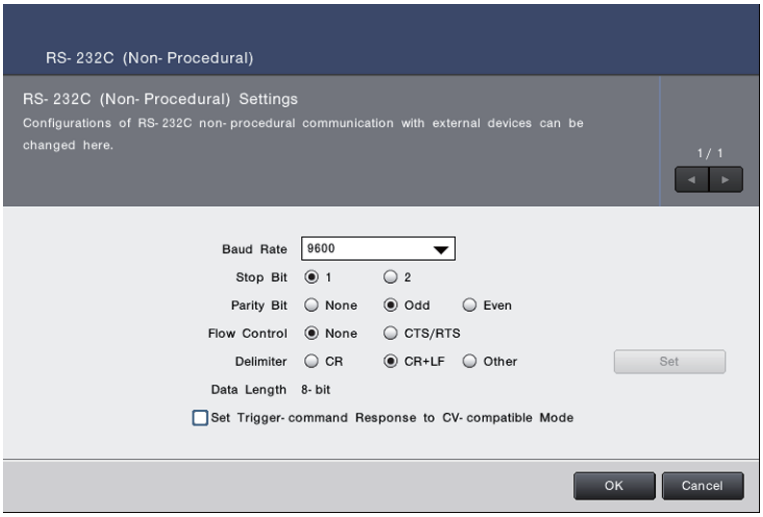
Image sensors

Model	Description
CV-X150F	Multi-camera image sensor (Ver. 2.1)
CV-200M (2 units)	2-million-pixel black and white camera

Communication settings

Match the communication settings of the image sensor to the RS-232C communication settings of the robot controller.

Communication settings of image sensor



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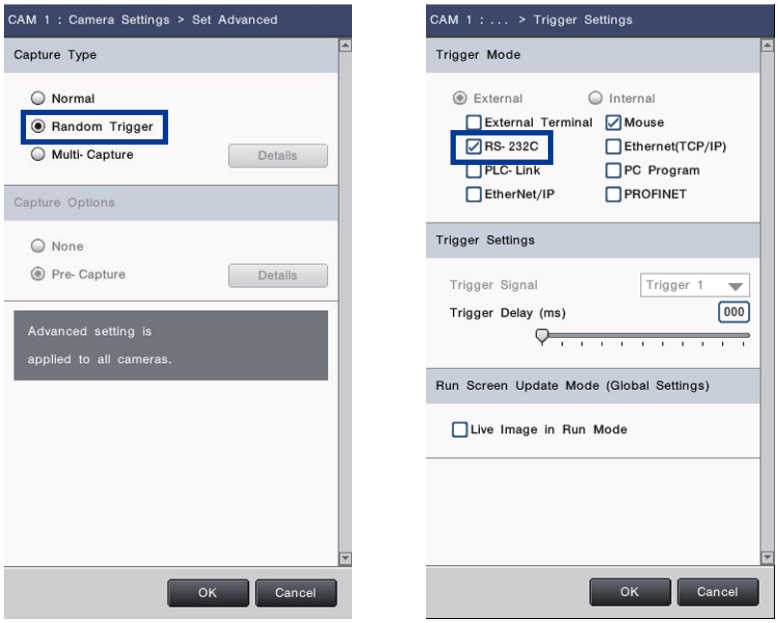
Camera settings

When multiple cameras are installed, check on [Random Trigger] to trigger each camera.
Additionally, check on [RS-232C] in the "Trigger Mode" area.

Camera settings

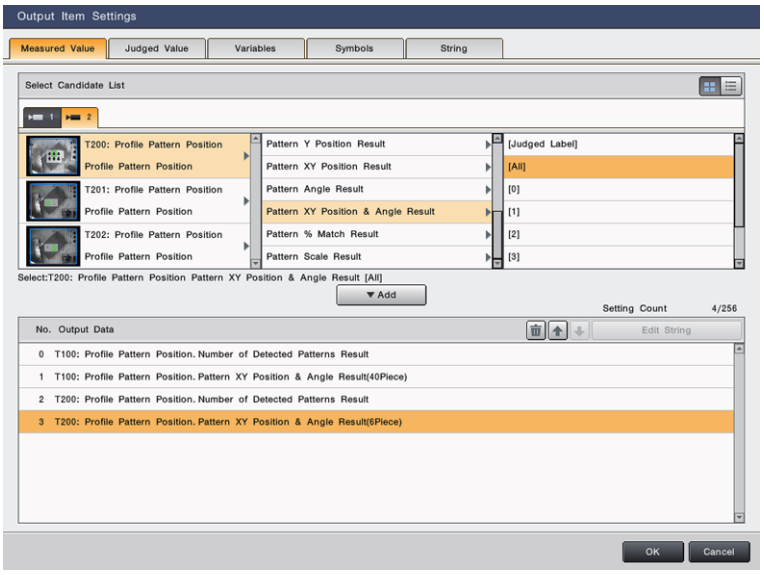


64034-T7-00

Output settings

Set the output items of the image sensor so that they meet the output format stated in "2.3 Output settings".
The following shows an example of output settings when using two cameras.

Output settings



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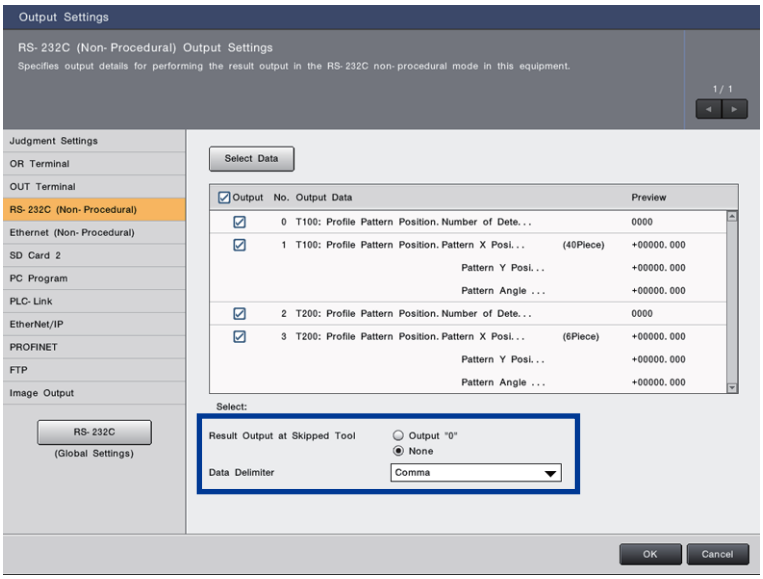
Check on [None] in the "Result Output at Skipped Tool" area and select "Comma" in the "Data Delimiter" field.

RS-232C (Non-Procedural) output settings



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When the output settings shown above are made, the data is output as follows.

■ Image capturing of camera 1 Two workpieces are detected.

<< T1

>> T1

>> 0002,+00268.465,+00150.117,-00009.146,+00224.879,+00258.308,-00009.127

■ Image capturing of camera 2 One workpiece is detected.

<< T2

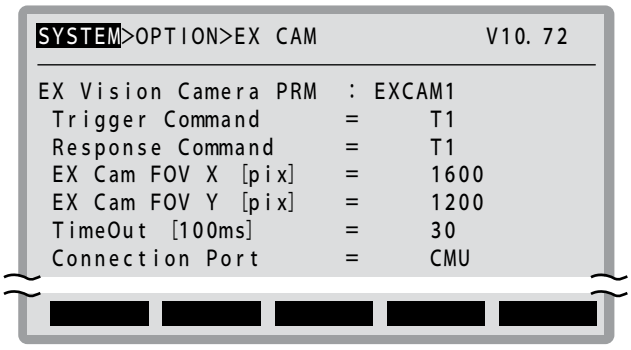
>> T2

>> 0001,+00308.401,+01150.829,-00010.002

■ External vision parameter settings

Set the external vision parameters for the robot controller.
The image capturing command (trigger command) of KEYENCE CV-X series is "Tn (n shows the camera number.)".
Additionally, the response character string (response command) when the image sensor accepts the image capturing command successfully is "Tn (n shows the camera number.)" that is the same as the image capturing command.

External vision 1 settings


SYSTEM>OPTION>EX CAM V10.72
EX Vision Camera PRM : EXCAM1
Trigger Command = T1
Response Command = T1
EX Cam FOV X [pix] = 1600
EX Cam FOV Y [pix] = 1200
TimeOut [100ms] = 30
Connection Port = CMU

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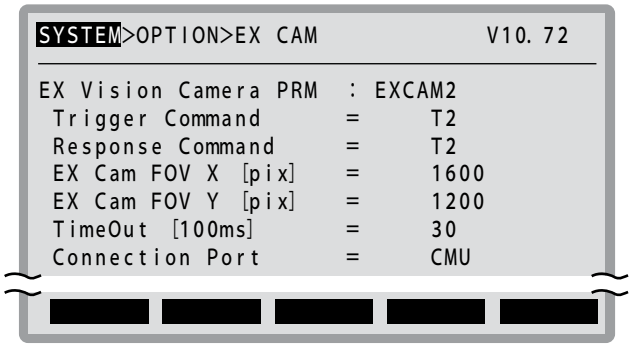
External vision 2 settings


SYSTEM>OPTION>EX CAM V10.72
EX Vision Camera PRM : EXCAM2
Trigger Command = T2
Response Command = T2
EX Cam FOV X [pix] = 1600
EX Cam FOV Y [pix] = 1200
TimeOut [100ms] = 30
Connection Port = CMU

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7.1.2 OMRON FZ4 series

The following describes an example of connections with OMRON image sensor "FZ4 series".

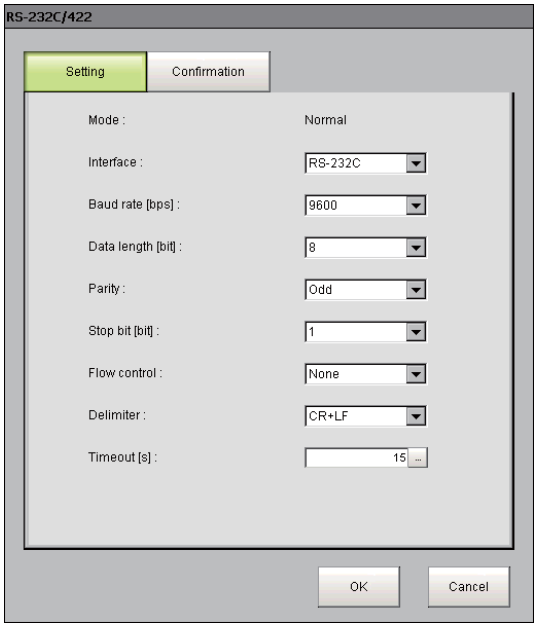
Image sensors

Model	Description
FZ-4 xxx	Image sensor (Ver. 4.21)
FZ-SC	300-thousand-pixel color camera

Communication settings

Match the communication settings of the image sensor to the RS-232C communication settings of the robot controller.

Communication settings of image sensor

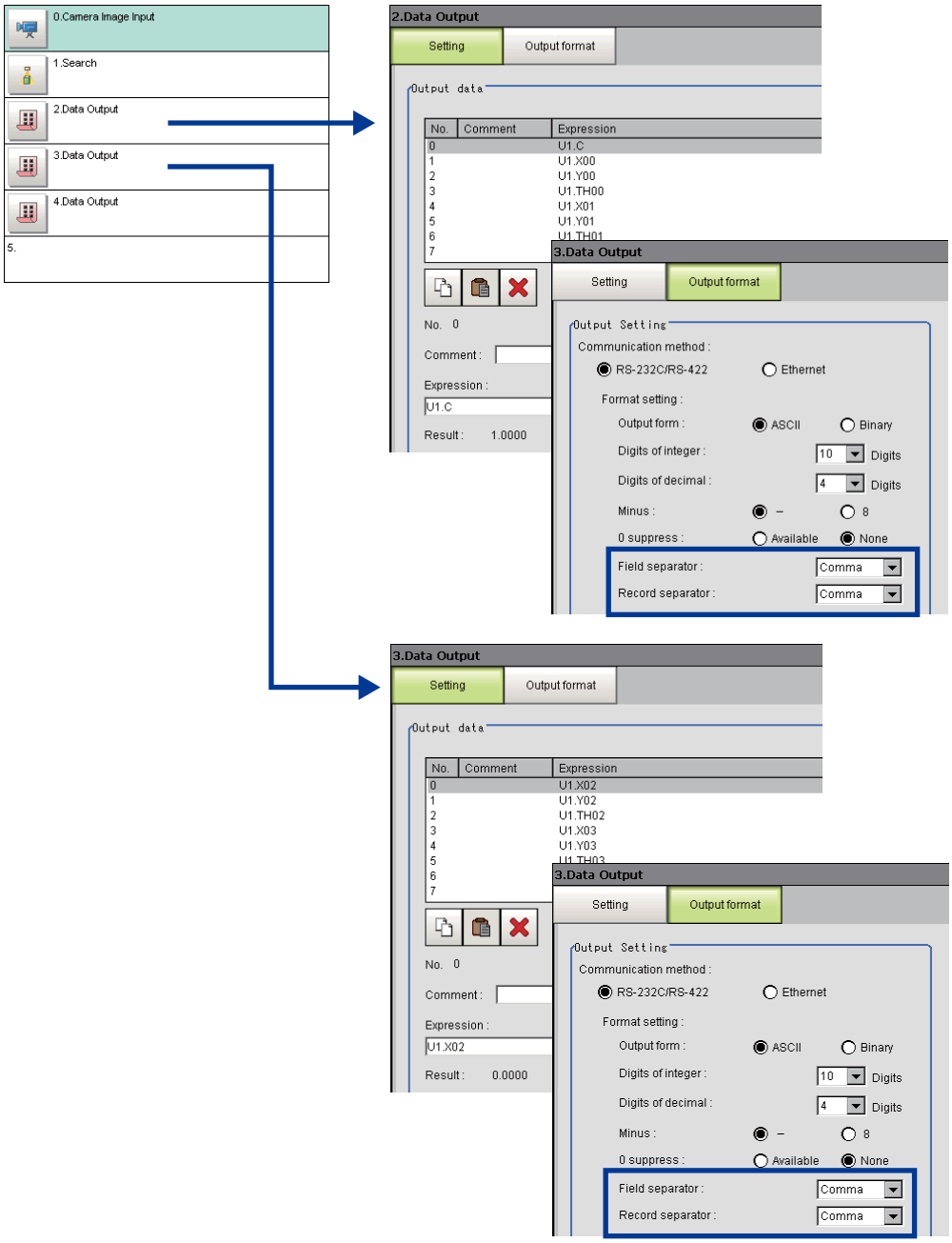


64039-T7-00

Output settings

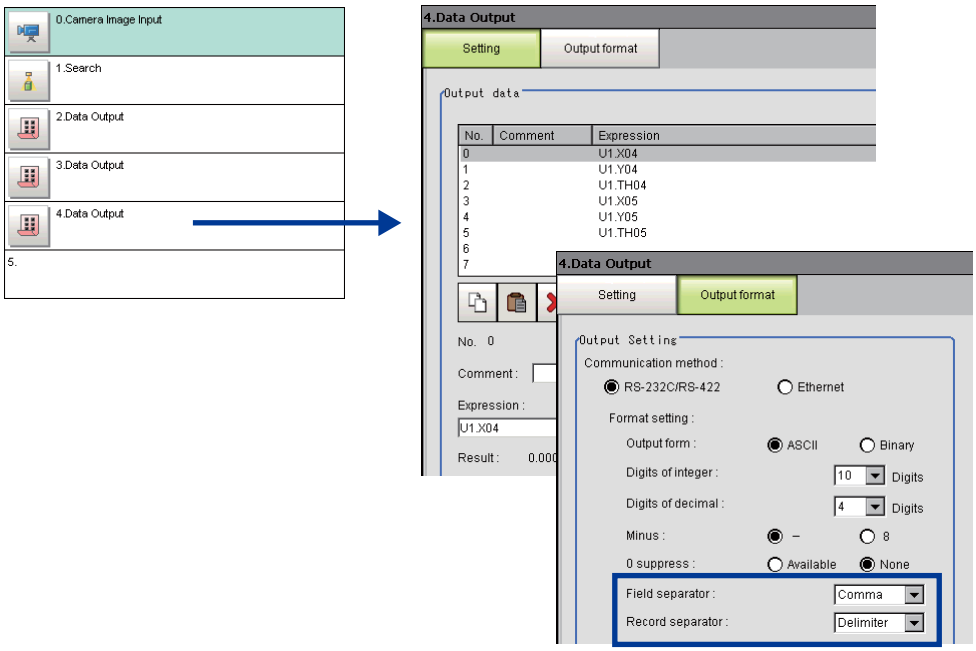
Set the output items of the image sensor so that they meet the output format stated in "2.3 Output settings". The following shows an example of settings to detect up to six workpieces.

Output settings (1)



64040-T7-00

Output settings (2)



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To detect multiple workpieces simultaneously, make the settings as shown above so that each data is separated by a comma and a delimiter is put at the end of the data.
When the output settings are made as described above, the data is output as follows.

■ Two workpieces are detected.

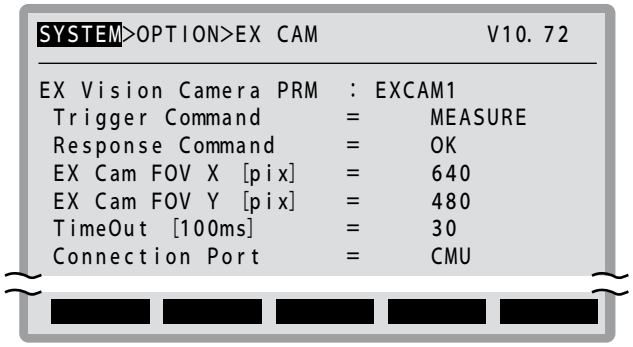
<< MEASURE
>> OK
>> 2.0000, 452.5440, 212.2505, 176.0000, 441.1120, 82.3567, 176.0000,
0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000,
0.0000, 0.0000, 0.0000, 0.0000, 0.0000

* Character strings after the X, Y, and angle data for the number of detected workpiece are discarded.

■ External vision parameter settings

Set the external vision parameters for the robot controller.
The image capturing command (trigger command) of OMRON FZ4 series is "MEASURE". Additionally, the response character string (response command) when the image sensor accepts the image capturing command successfully is "OK".

External vision settings


SYSTEM>OPTION>EX CAM V10.72
EX Vision Camera PRM : EXCAM1
Trigger Command = MEASURE
Response Command = OK
EX Cam FOV X [pix] = 640
EX Cam FOV Y [pix] = 480
TimeOut [100ms] = 30
Connection Port = CMU

64042-T7-00

7.1.3 OMRON FQ-M series

The following describes an example of connections with OMRON image sensor "FQ-M series".

Image sensor

Model	Description
FQ-MS120	Image sensor (Ver. 1.4)

Trigger settings

Check the trigger settings of the image sensor. Set "TRIG" in the "Trigger type" field.

Communication settings of image sensor

Trigger type

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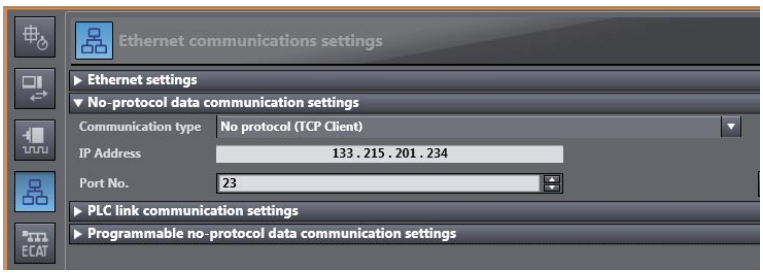
Communication settings

Match the communication settings of the image sensor to the Ethernet communication settings of the robot controller. Select "No protocol (TCP Client)" for the communication type on the FQ-M side, and then set the IP address of the robot controller for the IP address at the output destination and the port number of the robot controller for the port number at the output destination.

Communication settings of image sensor

Ethernet communication settings



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NOTE

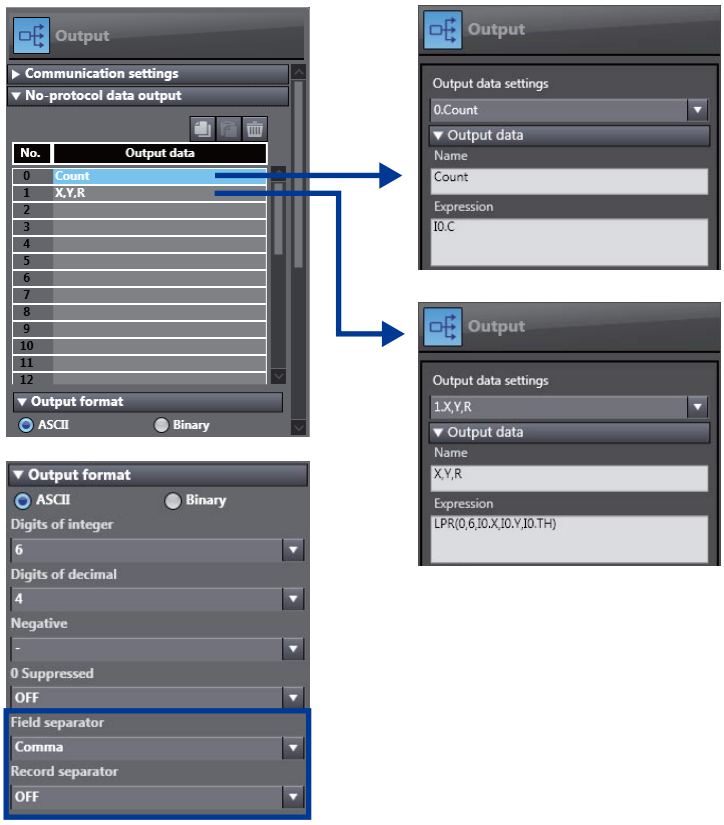
Set the Ethernet communication of the robot controller as follows.

6. Echo back Invalid
8. Login check Invalid
12. Keep alive (sec) 1

■ Output settings

Set the output items of the image sensor so that they meet the output format stated in "2.3 Output settings". The following shows an example of settings to detect up to six workpieces.

Output settings



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When the output settings are made as described above, the data is output as follows.

■ Two workpieces are detected.

<< MEASURE

>> OK

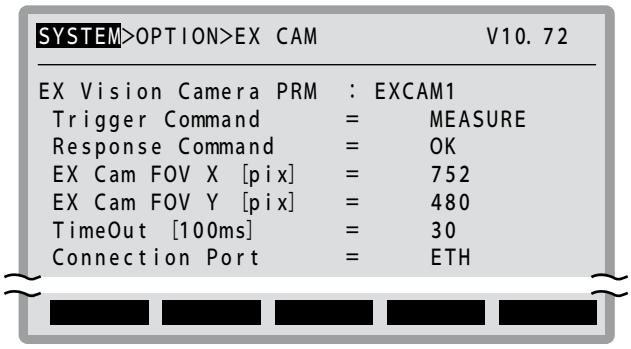
>> 2.0000, 452.5440, 212.2505, 176.0000, 441.1120, 82.3567, 176.0000,
0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000,
0.0000, 0.0000, 0.0000, 0.0000, 0.0000

* Character strings after the X, Y, and angle data for the number of detected workpieces are discarded.

External vision parameter settings

Set the external vision parameters for the robot controller.
The image capturing command (trigger command) of OMRON FQ-M series is "MEASURE". The response character string (response command) when the image sensor accepts the image capturing command successfully is "OK".

External vision settings


SYSTEM>OPTION>EX CAM V10.72
EX Vision Camera PRM : EXCAM1
Trigger Command = MEASURE
Response Command = OK
EX Cam FOV X [pix] = 752
EX Cam FOV Y [pix] = 480
TimeOut [100ms] = 30
Connection Port = ETH

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7.1.4 COGNEX In-Sight EZ series

The following describes an example of connections with COGNEX image sensor "In-Sight EZ series".

■ Image sensor

Model	Description
In-Sight EZ-700	Camera integrated image sensor

■ Sample job loading

A sample job is available when using "In-Sight EZ-700". Connect the image sensor and communication software to load this sample job.

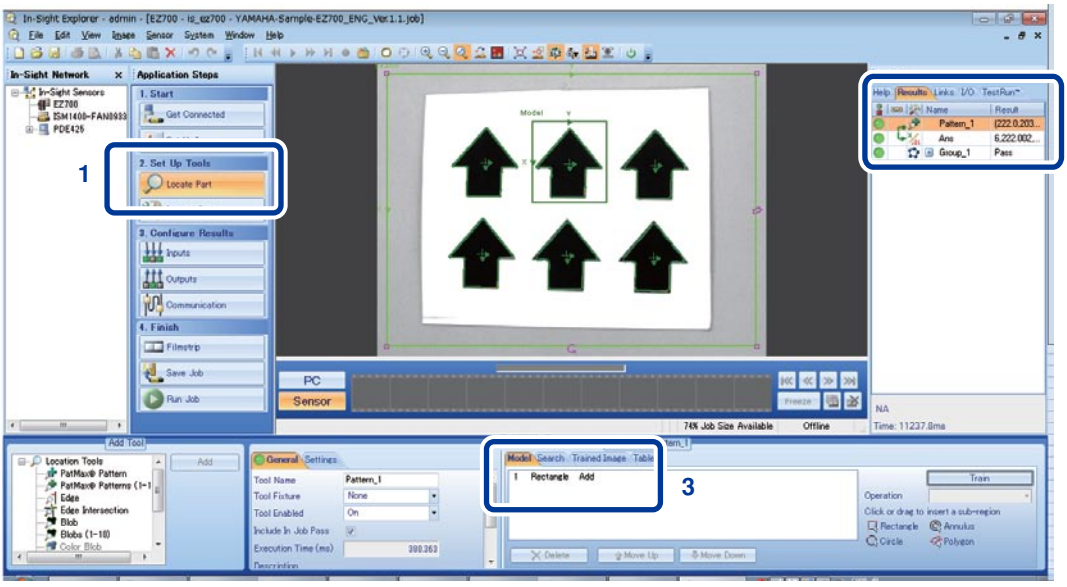
* The sample job can detect up to six workpieces through one image capturing.
* For details about how to obtain the sample job, contact your distributor.

■ Tool settings

Change the tool settings of the sample job corresponding to the workpiece. (See the figure below.)

1. From "2. Set Up Tools" in "Application Steps", select "Locate Part".
2. From "Results" in "Pallet", select "Patern_1".
3. Select the [Model] tab and set the workpiece to be detected.

Tool settings



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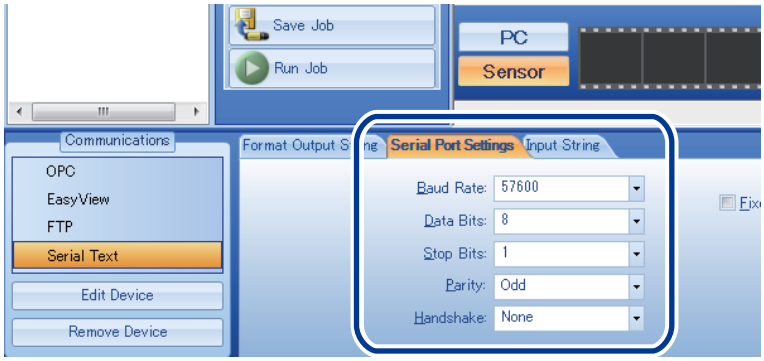
■ Output settings

The output settings are already made in the sample job. Change the settings when necessary.

Communication settings

Match the RS-232C communication settings of the image sensor to the communication settings of the controller.

Communication settings of image sensor



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Since the external image capturing command using character strings is not accepted when the communication settings are set at "Serial Text", follow the steps below to make it possible to use "native command".

Step 1 ***Check that the image sensor is in the offline mode.***

Step 2 ***Connect to the image sensor through the Ethernet communication.***

Run the terminal software ("Hyper Terminal", etc. for Windows), and enter the IP address of the image sensor and port number 23 (TELNET communication) to connect to the image sensor.

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Step 3 ***Send the native command to the image sensor.***

After checking that the communication is connected to the image sensor correctly, send the native command shown below through the Ethernet communication.
EV SetSerialPort(1,7,57600,8,1,512,0,0,0,13,13,0,0,0)

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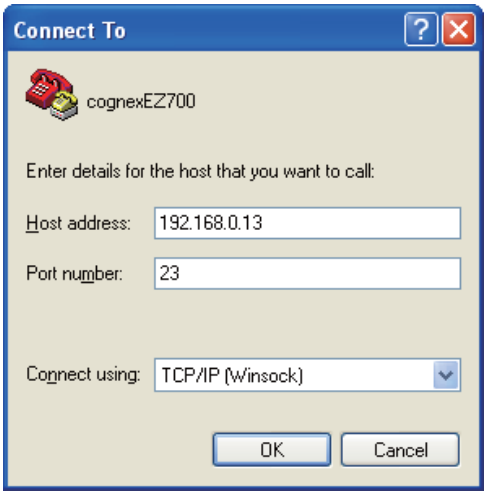
When the image sensor accepts the native command successfully, "1" is returned as return value. Additionally, the image sensor is set as follows and the native command becomes valid in the RS-232C communication.

SerialPortNum:	1
Mode:	7 (Native mode)
BaudRate:	57600
DataBits:	8
StopBits:	1
Parity:	512 (Odd)
Handshake:	0 (None)
InputPacketSize:	0
OutputPacketSize:	0
InputTerminator:	13(CR)
OutputTerminator:	13(CR)
FixedInputMode:	0
FixedInputLength:	0
DeviceNetTrigger:	0

NOTE

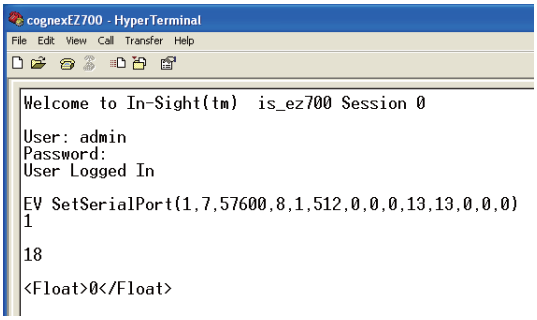
Change values other than "Mode:7" when necessary.

Step 2 Connecting to the image sensor



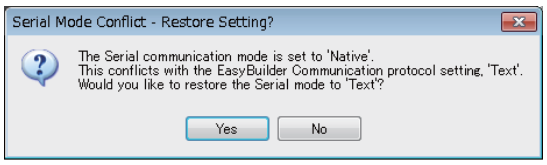
* The settings shown above are those when using Hyper Terminal.

Step 3 Sending the native command



NOTE

When the operation shown above is performed, the following message may appear. In this case, be sure to press (No). If you press (Yes) by mistake to restore the settings, perform steps 1 to 3 again.


Serial Mode Conflict - Restore Setting?
The Serial communication mode is set to 'Native'.
This conflicts with the EasyBuilder Communication protocol setting, 'Text'.
Would you like to restore the Serial mode to 'Text'?
Yes
No

Step 4 Put the image sensor in the online mode.

Step 5 Send the character string "SE8" to the image sensor through the RS-232C communication.

Check that images are captured and the image capture results are output as follows.

* The number of workpiece detections is 6.

<< SE8

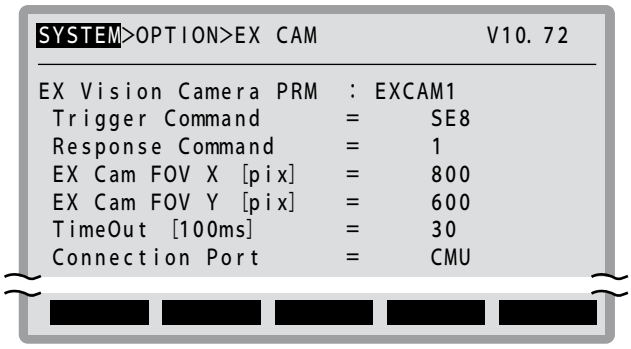
>> 1

>> 6,187.099,245.205,1.294,180.115,411.737,0.775,335.788,417.402,0.813,342.071,250.988,
1.037,491.151,422.774, 0.803,496.692,257.108,0.733

External vision parameter settings

Set the external vision parameters for the robot controller.
The image capturing command of COGNEX EZ series is "SE8". The response character string when the image sensor accepts the image capturing command successfully is "1".

External vision settings


SYSTEM>OPTION>EX CAM V10.72
EX Vision Camera PRM : EXCAM1
Trigger Command = SE8
Response Command = 1
EX Cam FOV X [pix] = 800
EX Cam FOV Y [pix] = 600
TimeOut [100ms] = 30
Connection Port = CMU

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7.1.5 COGNEX In-Sight Micro series

The following describes an example of connections with COGNEX image sensor "In-Sight Micro series".

■ Image sensors

Model	Description
In-Sight 1400	Camera integrated image sensor
CIO-MICRO-CC	Expansion I/O module

■ Sample job loading

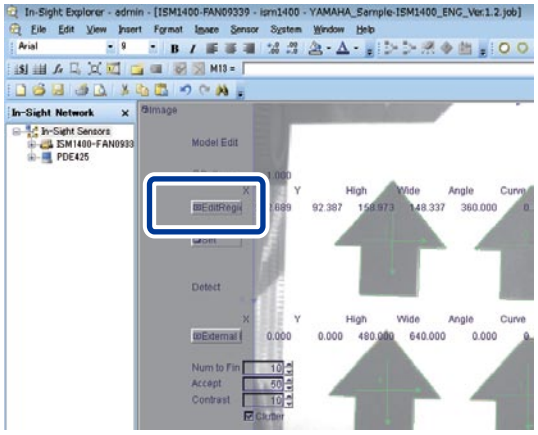
A sample job is available when using "In-Sight 1400". Connect the image sensor and communication software to load this sample job.

* The sample job can detect up to ten workpieces through one image capturing.
* For details about how to obtain the sample job, contact your distributor.

■ Tool settings

Change the tool settings of the sample job corresponding to the workpiece. From [Edit Region] of the sample job, register the workpiece to be searched for.

Tool settings



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■ Output settings

The output settings are already made in the sample job. Change the settings when necessary.

* Output example: The number of detected workpieces is 10.

<< SE8

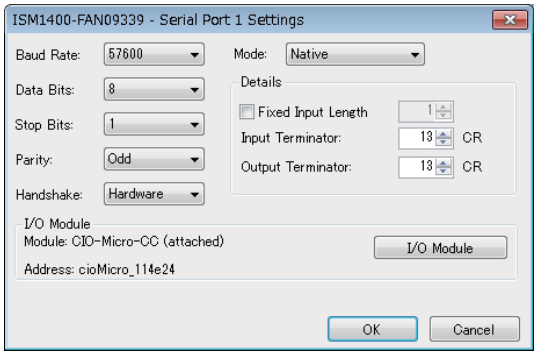
>> 1

>> 10,356.03,76.38,-49.154,289.03,153.88,40.809,57.93,429.67,40.060,132.85,339.65,40.179,40.42,362.34,
50.231,204.36,162.51,40.529,31.07,96.46,39.469,108.59,187.64,-49.841,369.07,59.61,41.111,283.781,
68.013,40.729

Communication settings

Match the RS-232C communication settings of the image sensor to the communication settings of the controller.

Communication settings of image sensor



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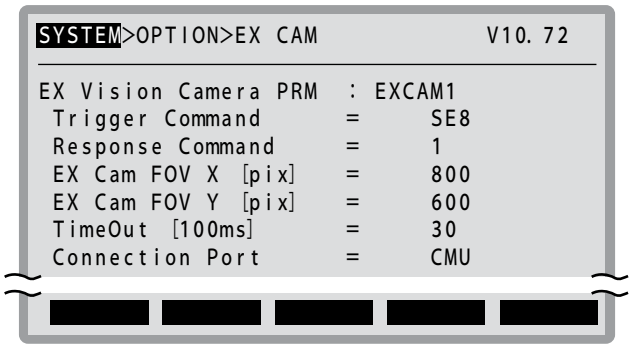
External vision parameter settings

Set the external vision parameters for the robot controller.
The image capturing command of COGNEX EZ series is "SE8". The response character string when the image sensor accepts the image capturing command successfully is "1".

External vision settings


SYSTEM>OPTION>EX CAM V10.72
EX Vision Camera PRM : EXCAM1
Trigger Command = SE8
Response Command = 1
EX Cam FOV X [pix] = 800
EX Cam FOV Y [pix] = 600
TimeOut [100ms] = 30
Connection Port = CMU

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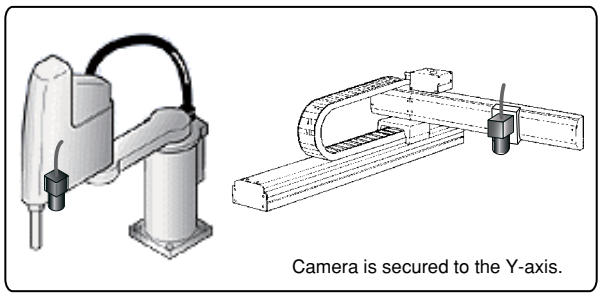
7.2 List of specifications

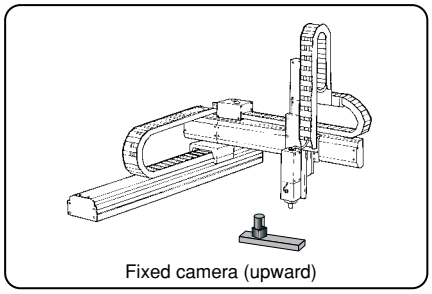
Applicable model examples	KEYENCE	CV-5000 series, CV-X100 series, XG series
	OMRON	FZ4 series, FQ-M series
	COGNEX	In-Sight EZ series, In-Sight series
	Other general-purpose image sensor, PC etc.	
Number of cameras	Max. 4 units *	
Camera installation direction	Fixed camera (upward, downward), secured to the robot Y-axis. Vertical to the image capturing target workpiece	
Max. number of workpiece detections	40 pcs. *	
Communication type	RS-232C or Ethernet	
Applicable commands (Common to iVY system)	VGETCNT, VGETPIX, VGETPOS	
	VGETPOSX, VGETPOSY	
Commands dedicated to external vision	EXSEARCH	
Parameters for external vision (For 4 cameras)	Image capturing command	
	Response character string	
	Number of camera pixels	
	Timeout	
	Port to be used (CMU/ETH)	
Calibration method	Interactive calibration method	
Number of calibration data	Max. 4	
Image sensor output settings	Number of detected workpieces, X-coordinate, Y-coordinate, angle	
	Each data is separated by a comma.	
	Delimiter is put at the end of the data.	

* This value may vary depending on the image sensor to be used.

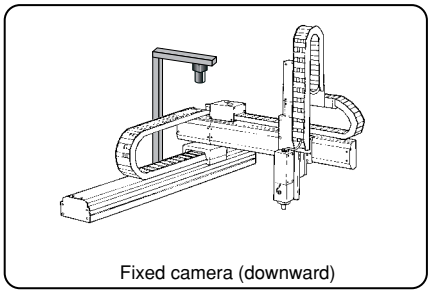
■ Examples of camera installations



Camera is secured to the Y-axis.



Fixed camera (upward)



Fixed camera (downward)

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7.3 Trademarks and registered trademarks

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Robot vision system

RCX240 Connection Manual

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Robot manuals can be downloaded from our company website.
Please use the following for more detailed information.
http://global.yamaha-motor.com/business/robot/

* For inquiries about the image sensor, please contact relevant manufacturer.

YAMAHA MOTOR CO., LTD.